Aquifer Exemption Request
Willow Sands
AM Idaho

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I. Statement that this is an Aquifer Exemption application

This document is submitted as an application for an Aquifer Exemption Request under 40 CFR 146.4. It is submitted as Attachment S to a previously submitted application for an injection permit for a Class II disposal well, UIC Permit Application No. ID2D001-A.

The aquifer exemption request area is limited to the Willow Sands aquifer from 4000' to 6000' below ground level in parts of seven sections, covering an area of 4 square miles. The area is in Township 8 North, Range 4 West and described as the NE/4 of Section 9, all of sections 10 and 11, the W/2 of Section 12, and the NW/4 of Section 13 and the N/2 of Sections 14 and 15.

II. Executive Summary

This application for an Aquifer Exemption sets out the support that the Willow Sands aquifer is eligible for an exemption determination. Under 40 CFR 146.4 an aquifer may be determined to be exempt if:

(a) it does not currently serve as a source of drinking water; and

(b) it cannot now and will not in the future serve as a source of drinking water because:

(1.) it is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible, or

(2.) it is situated at such a depth or location which makes recovery of water for drinking water purposes economically or technologically impractical; or

(3.) it is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption.

The conditions of the Willow Sands aquifer relating to each of the exemption factors above are addressed in detail in subsequent individual sections of this application, however they are summarized briefly in this section below:

***(a) it does not currently serve as a source of drinking water*:**

The Willow Sands aquifer is found at a depth of between 4000’ and 6000’ below ground level in the area of the proposed Aquifer Exemption. The depth and thickness of the aquifer is well established by the multiple oil and gas wells drilled in this area, which produce gas, condensate and oil from the Willow Sands reservoir. The area is rural, with only 4 Water wells within the geographic area of the proposed Aquifer Exemption. None of these water wells are deeper than 215’**,** and thus are producing their water from zones over 3700’ shallower than the Willow Sands. A detailed search was made over a 24 square mile area surrounding the exemption area utilizing the Idaho Department of Water database. No water wells were found that were deeper than 415’ in this 24 square mile search area. **Section IV** of this application contains maps, discussion and tables presenting the results of the area wide water well search. Individual records of each water well drilled within the 24 square mile search area are presented in **Appendix IV.** As there are no water wells that come closer in depth than 3700’ above the Willow Sands aquifer, it is concluded that the aquifer is not currently serving as a source of drinking water.

(b) it cannot now and will not in the future serve as a source of drinking water because:

(1.) it is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible

The requested Willow Sands aquifer is a commercially producing gas condensate reservoir comprising the Willow Field. There are 9 active wells which produce gas, condensate and oil from the Willow Sands. The field has produced over 11.6 Billion cubic feet of natural gas, 438,000 barrels of condensate and oil, and 17 million gallons of natural gas liquids. The Field is currently producing an average of 3.6 Million cubic feet of natural gas per day, 100 barrels of condensate per day, 4500 Gallons of natural gas liquids per day, and 10 barrels of water per day. Quite simply, our intent is to re-inject this associated produced water back in to the same Willow Sands aquifer from which it is produced. **Section V** of this application contains discussion, maps, cross-sections, well production summaries and other information which document that the Willow Sands aquifer in the requested Aquifer Exemption area is hydrocarbon producing.

Satisfying the requirements of the above 2 exemption factors (a) and (b)(1) is sufficient to allow granting of an Aquifer Exemption under the statute. However, our analysis concludes that the Willow Sands aquifer may be exempted under sections (b)(2) and (b)(3) as well:

Section (b)(2) states that an aquifer may be determined to be exempt if: ***"it cannot now and will not in the future serve as a source of drinking water because… (2.) it is situated at such a depth or location which makes recovery of water for drinking water purposes economically or technologically impractical; or".***

The cost to drill and complete a 5000' to 6000' well to the Willow Sands to produce water is estimated to be $2.95 Million. There are other much shallower zones locally that are currently being used (60' to 300') for drinking water where wells can be drilled for $25,000. There are also other possible aquifers in the general area at 600' to 1300' that could be accessed. As this area is rural and very lightly populated, and the current water needs are being met by shallower aquifers, it does not make economic sense to drill deep, 5000' to 6000' wells to access water in the Willow Sands aquifer. This point is discussed in more detail in **Section X** of this application.

Section (b)(3) states that an aquifer may be determined to be exempt if: ***"it cannot now and will not in the future serve as a source of drinking water because… (3.) it is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption, or…"***

We have done extensive sampling and analyses of the water contained in the Willow Sands aquifer. All of the water samples analyzed from the aquifer show the presence of benzene, toluene, ethylbenzene and xylene in levels unacceptable for drinking water. The levels measured are consistent with the fact that commercial hydrocarbons are present in the reservoir, these species of hydrocarbons are very commonly found in oil and gas fields. We have had third party analyses done of the cost to treat the water to render it useable for drinking and the costs are economically prohibitive. **Section VII and VIII** of this application shows maps of sampled wells, summary tables of test results, cross-sections showing sampled intervals, and further discussion. **Appendix VII** has the full water analyses for the sampled wells and intervals. This section also discusses the sampling protocols and test methods used.

Aerial Photo showing Location of Proposed Aquifer Exemption Area within the State of Idaho

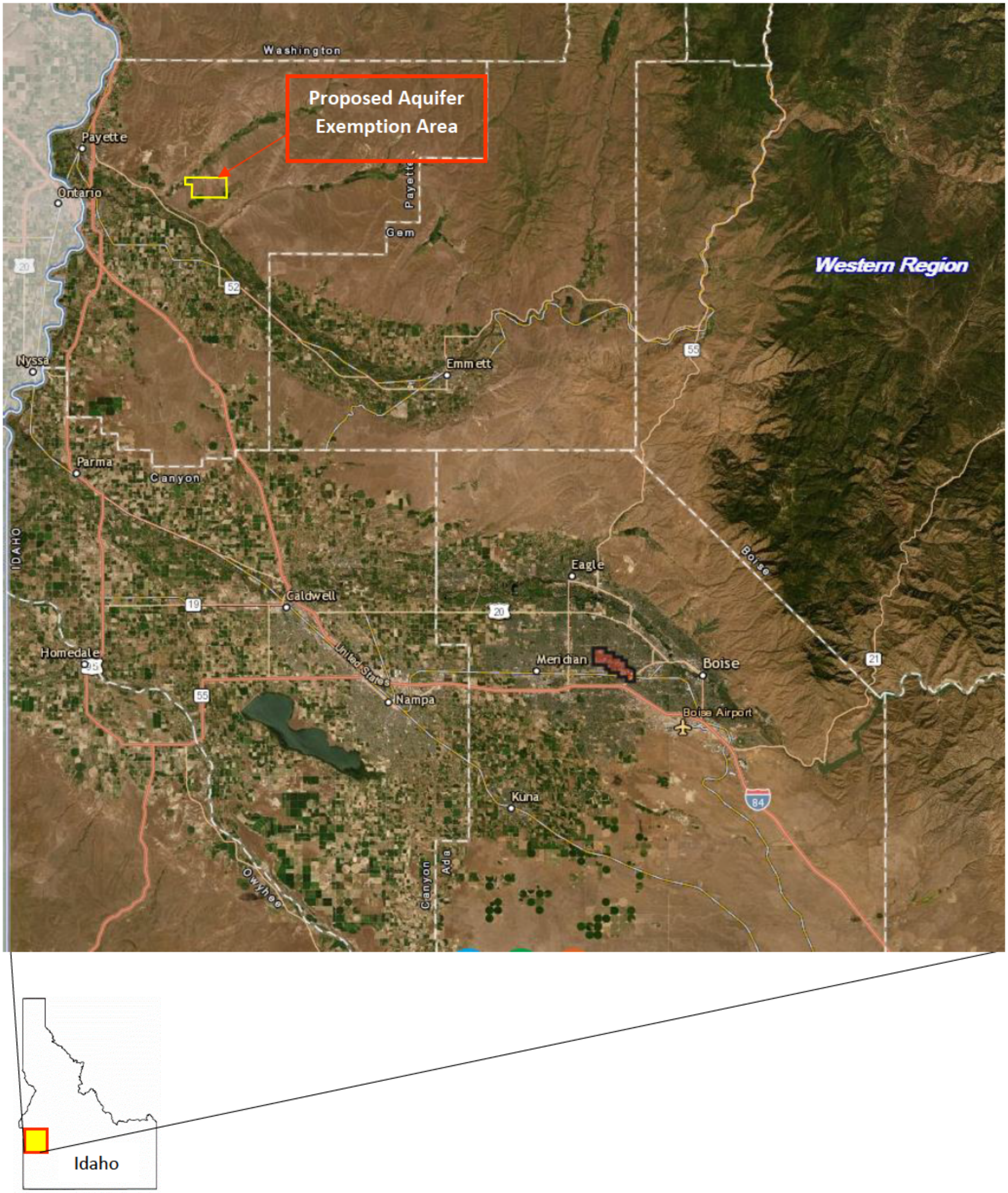


Exhibit III-A

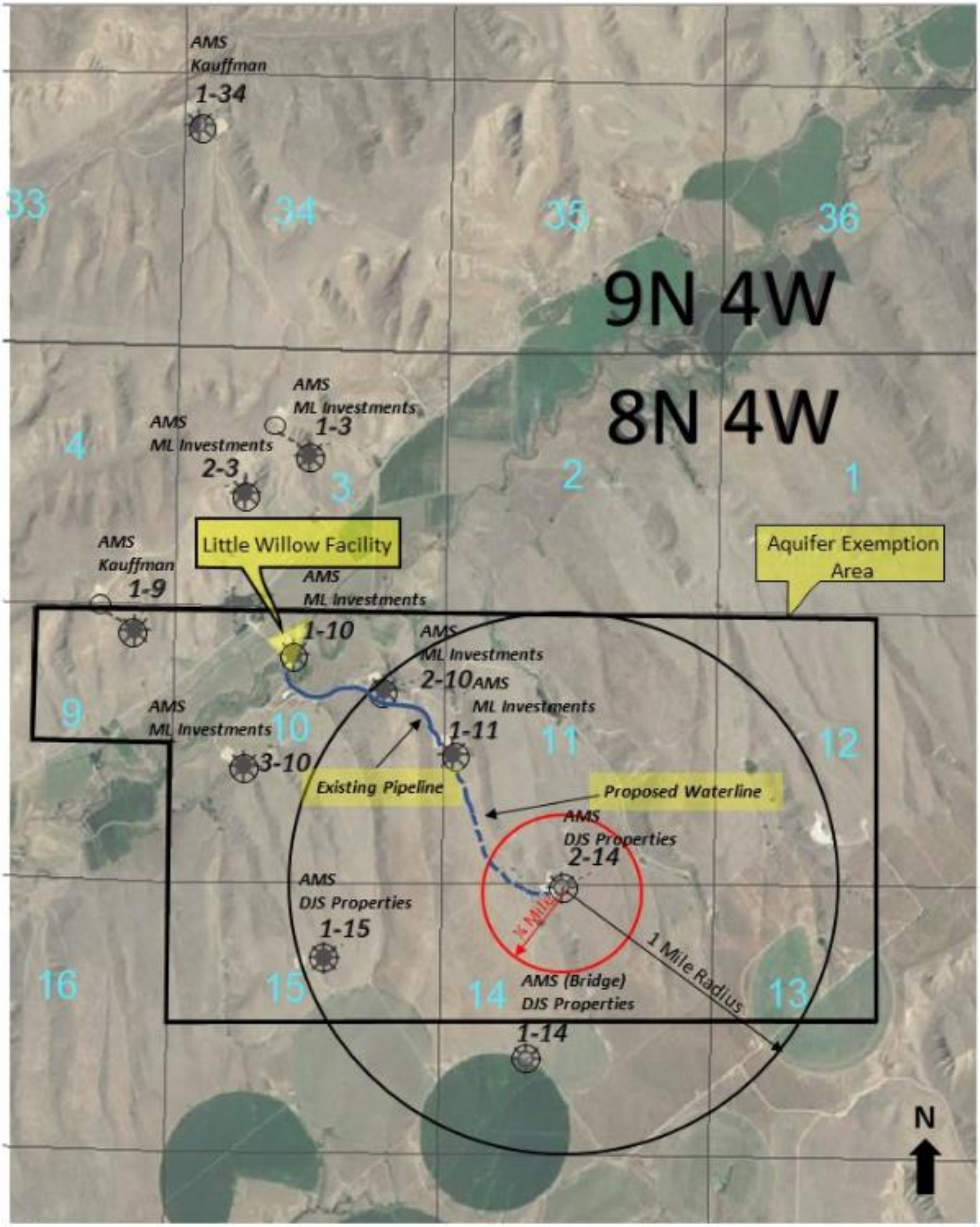
III. Project Area Description

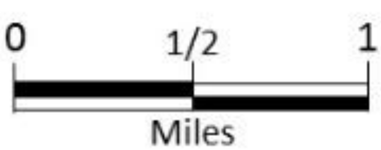
The proposed Aquifer Exemption (AE) area is strictly for the Willow Sands member of the lower Chalk Hills Formation, found at a depth of generally 4000’ to 6000’ below ground level, over an area comprising the southern half of the Willow Oil and Gas Field. The AE area is proposed to include only the Willow Sands aquifer, from 4000’ to 6000’, in parts of 7 sections, covering an area of 4 square miles or 2560 acres (**Exhibit III-A & B).** The specific AE request area is for the NE/4 of Section 9, all of Sections 10 and 11, the W/2 of Section 12, the NW/4 of Section 13, and the N/2 of Sections 14 and 15, all in Township 8 North Range 4 West. This AE request is strictly limited to the Willow Sands, which are a commercially producing oil and gas reservoir in this area and beyond, and will not impact any other aquifers (see **Exhibit III-C**, Composite Type Lithologic Section).

The area of the Willow Field is very rural and lightly settled. The surface topography is dominated by broad rolling hills and steep bluffs with surface elevations ranging from 2230’ to 2600’ above sea level. Approximately 90% of the proposed exemption area is this type of rugged terrain, it is primarily used for ranching, cattle grazing, and oil and gas production activities. There is an area of pivot irrigation on high plateaus which touches the southern part of the area. Alfalfa for cattle feed is the dominant crop raised there. About 10% of the AE area is a small section of the valley of Little Willow Creek. Traversing the northwest edge of the AE area, the valley is about 2500’ wide and relatively flat, but gently dips to the southwest in the direction of the creek’s drainage. There is farming and cattle grazing in the valley. The few houses in this area are found along this valley. Our Little Willow oil and gas production and gathering facility is also there. Pictures of the project area are included in **Exhibit III-D (**pages 11 – 14). A picture location reference map is on page 15.

The Ecoregions of Idaho Project is part of an interagency effort (between USEPA Region X, USEPA-NHEERL (Corvallis), IDEQ, USFS, USDA-NRCS, BLM, USGS, and EROS) to describe and categorize ecological regions within the state of Idaho. This study categorizes the broad region within the Snake River Plain that the AE area is within as “12 J – Unwooded Alkaline Foothills”. The description from the study of this type of ecoregion is below:

“The shrub- and grass-covered **Unwooded Alkaline Foothills** ecoregion is higher and more rugged than Ecoregion 12a. Sandy, alkaline lacustrine deposits occur unlike in other ecoregions and support a unique flora. Potential natural vegetation is saltbush–greasewood and sagebrush steppe. Today, cheatgrass and crested wheatgrass are also common and the ecoregion is used for livestock grazing. Land use is unlike that of Ecoregions 12a and 12i. Perennial streams are rare and are much less common than in Ecoregion 1.”





Willow Field

Payette County, Idaho

Google Earth Image 7/19/2018

Exhibit III-B

Composite Lithologic Type Log

DJS 2-14 & ML 1-10 Wells

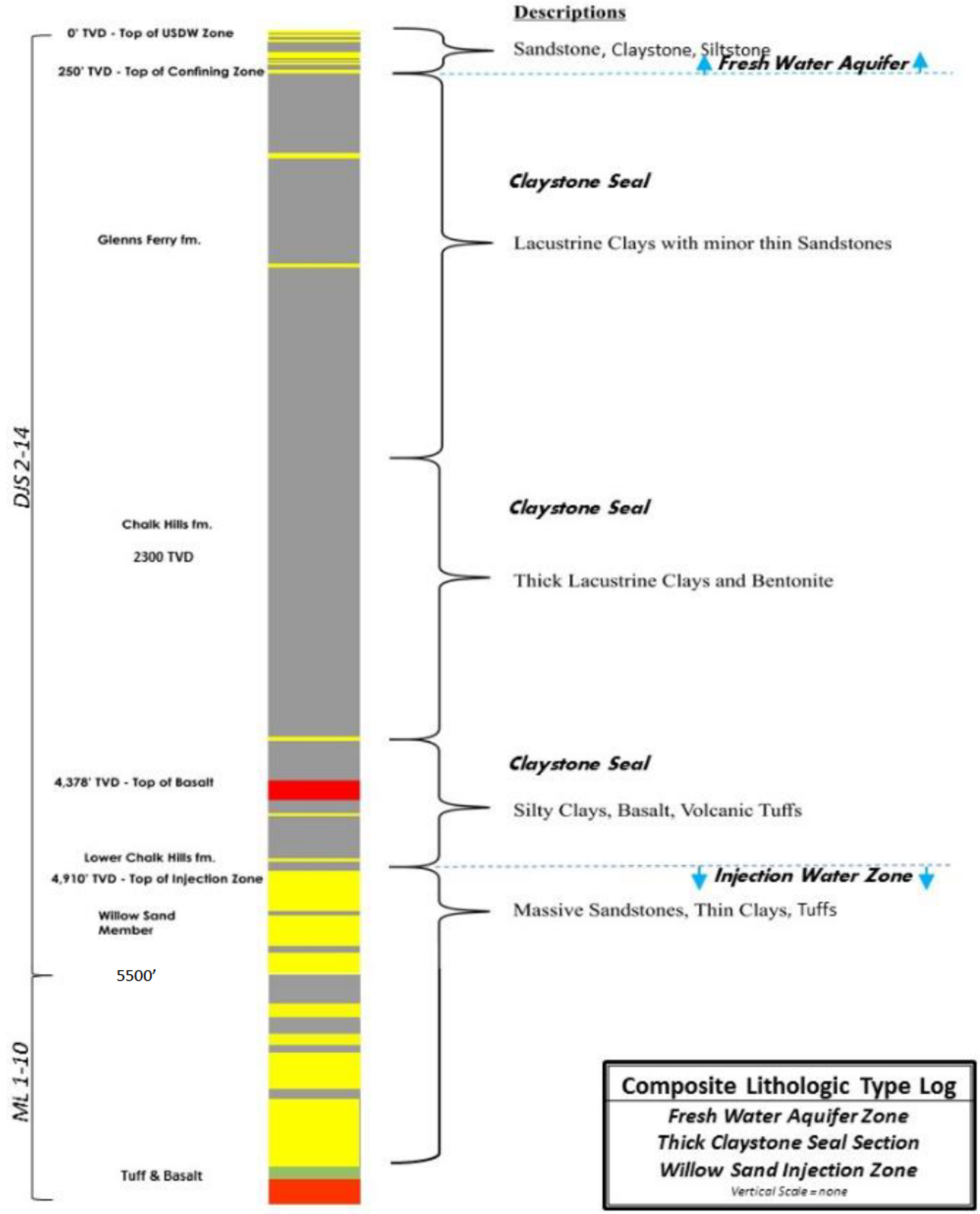


Exhibit III-C

#1 - Looking North from Proposed Injection Well (DJS #2-14)

Exhibit III-D

#2 - Looking West from Proposed Injection Well (DJS #2-14)

#3 - Looking South from Proposed Injection Well (DJS #2-14)

#4 - View looking NE from Kauffman 1-9, drilling rig on ML 1-3, ML 2-3 location in middle

#5 - View looking North to Kauffman #1-34

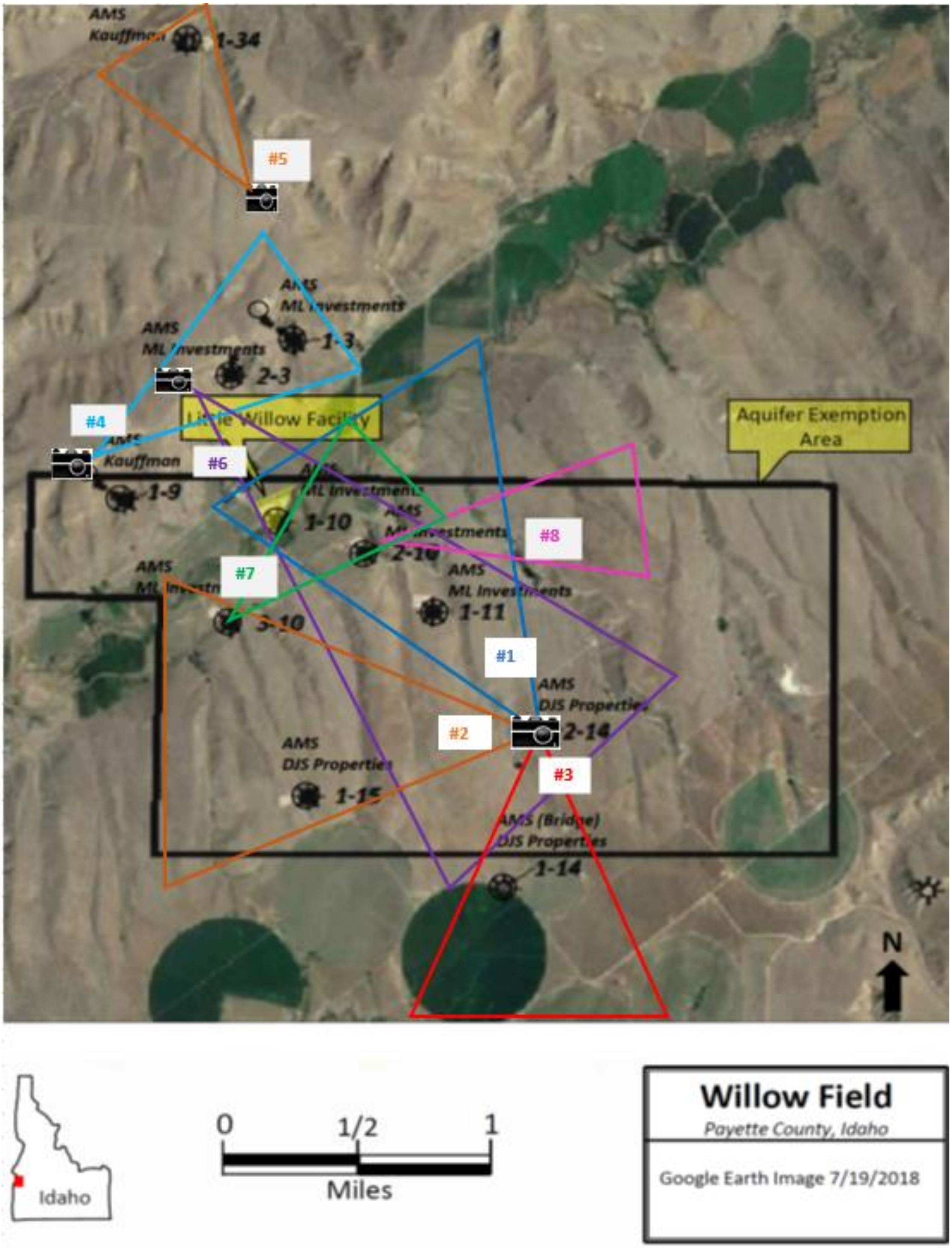
#6 – View looking Southeast overlooking LWPF, ML Inv 2-10, ML Inv 1-11 and DJS 2-14 (proposed injection well).

Exhibit III-D Cont.

#7 - Looking Northeast from ML 3-10

8 -Looking East from ML 2-10

Exhibit III-D Cont.



VIEW OF LANDSCAPES WITH PHOTO ORIGINS

IV. Evidence supporting 40 CFR 146.4 (a)

In researching the drinking water wells within the nearby and the proposed exempted area for the aquifer exemption it is evident that there are no water wells that will use the proposed exempted portion of the aquifer as a source of drinking water as the proposed exempted area is between 4000' and 6000' deep and the deepest water well located in the exemption area is 215' deep.

The proposed exemption area is located in the south west portion of Idaho. The water wells in the area were located using the Idaho Department of Water Resources (IDWR) well data at https://idwr.idaho.gov/wells/find-a-well.html. To verify the depth of one well in the Proposed Aquifer Exemption area we contacted the land owner as noted in the tables in the following exhibits.

Exhibit IV-A is a map indicating all water wells located in a 24 square mile search area (as noted by the red box) surrounding the proposed aquifer exemption identified using the IDWR website. Using the well reports from the 24 square mile area downloaded from the IDWR website the following requested information is compiled in the table in **Exhibit IV-B**: Well Name/#, Owner, (Private/Public), Contact information, Purpose of the well (Domestic, Irrigation, Livestock, etc.), depth of source water, name for aquifer, well completion data, age of well (if known), and the primary source of well data (Applicant/State/Tribe/EPA)

Zooming in closer around the area of exemption **Exhibit IV-C** shows a map indicating All Water Wells within a 1-mile radius of the Proposed Aquifer Exemption Area (indicated by the red box). **Exhibit IV-D** shows the table with the water wells within the 1-mile radius listed with EPA requested information.

Exhibit IV-E indicates only the water wells in the Aquifer Exemption area (designated by the red box). There are 6 wells (two duplicates/re-drills) within the proposed area identified by the Idaho Department of Water Resources. As previously stated the deepest of these wells is 215'.

The table with the water wells information within the Proposed Aquifer Exemption Area is **Exhibit IV-F**. There are 3 domestic water wells, 1 stock water well and 1 cathodic protection well at our Little Willow Production Facility. The IDWR has one well located in T8N R4W S15 which did not have a log on file; according to the landowner the well does not exist.

So in summary there are only three domestic and one stock water wells within the proposed aquifer ecemption area, none deeper than 215'.

The depths of the water wells within the Proposed Aquifer Exemption Area and the depth of the typical Willow Sand oil & gas well is shown on the comparative graph in **Exhibit IV-G.**

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All Water Wells within a 24 Square Mile Search Area Surrounding Proposed Aquifer Exemption Area

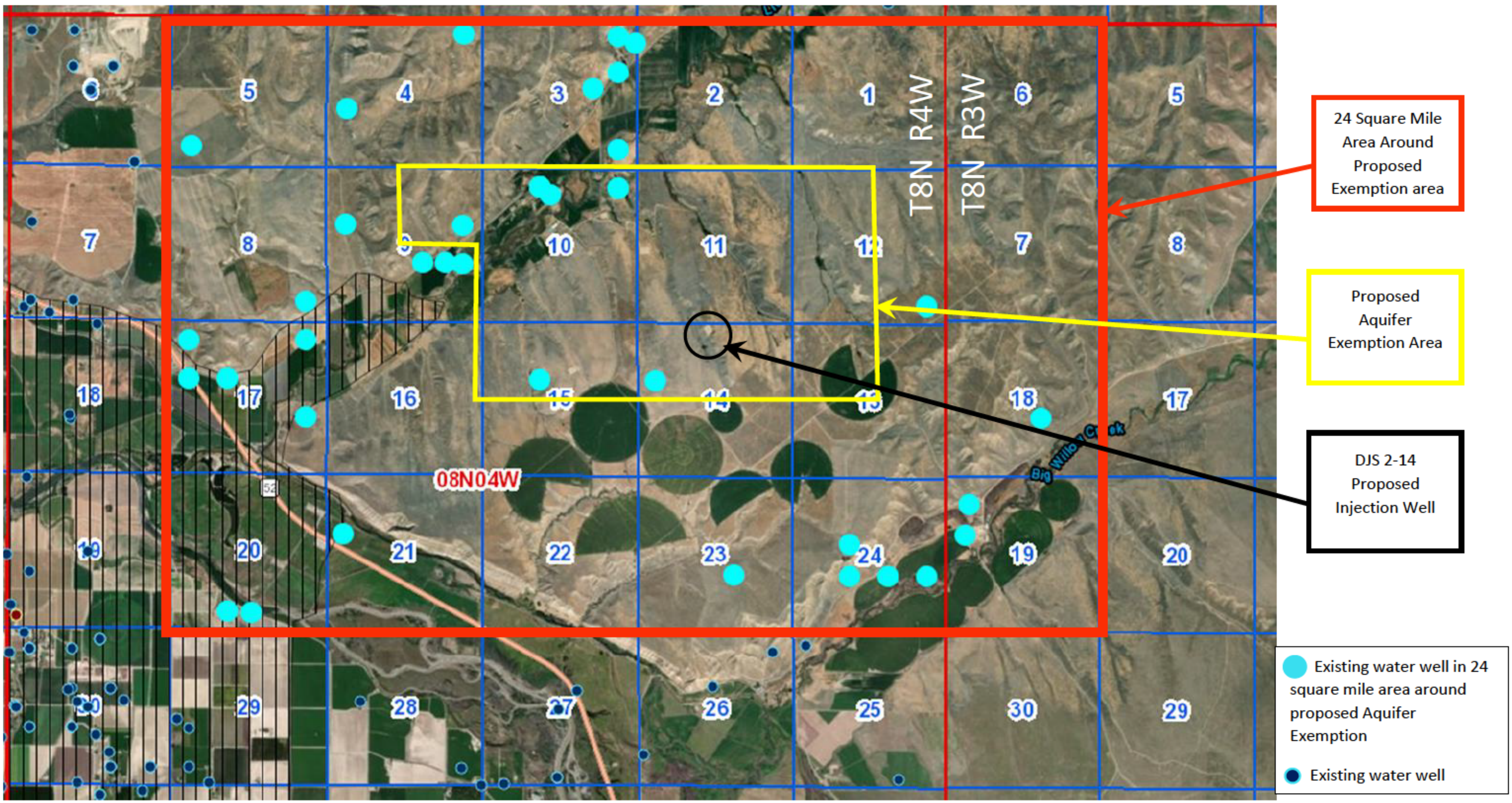

Exhibit IV-A

Table of All Water Wells within a 24 Square Mile Search Area Surrounding Proposed Aquifer Exemption Area

WellID	PermitID	Owner	Private /Public	Contact Address	Contact City	State	Contact Zip Code	Purpose of well	Static Water Level	Name of Aquifer	Completion Data: Casing Depth	Completion Data: Total Depth	Construction Date	Source of Well Data	TWN	RGE	SEC
289347	738618	(b) (6) [redacted]	Private	(b) (6) [redacted]	Payette	ID	83661	Domestic-Single Residence	84	Shallow Alluvium	195	210	9-Dec-99	IDWR	08N	04W	3
290564	737503	[redacted]	Private	[redacted]	Payette	ID	83661	Domestic	89	Shallow Alluvium	139	185	11-May-97	IDWR	08N	04W	3
293017	735348	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	78	Shallow Alluvium	98	240	4-Nov-92	IDWR	08N	04W	3
346482	774643	[redacted]	Private	[redacted]	New Plymouth	ID	83655	Domestic	91	Shallow Alluvium	26	185	7-Jul-80	IDWR	08N	04W	3
377199	806364	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	80	Shallow Alluvium	169	183	17-Nov-64	IDWR	08N	04W	3
390171	819503	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	157	Shallow Alluvium	238	245	3-Apr-85	IDWR	08N	04W	3
292325	735439	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	8	Shallow Alluvium	22	25	22-Nov-92	IDWR	08N	04W	4
374907	804020	NEW PLYMOUTH ASSEMBLY OF GOD	Private	PO Box 107	New Plymouth	id	83655	Domestic	5	Shallow Alluvium	43.5	43	24-Jun-03	IDWR	08N	04W	4
392812	822154	(b) (6) [redacted]	Private	(b) (6) [redacted]	Ontario	OR	N/A	Domestic	12	Shallow Alluvium	37	37	3-Apr-73	IDWR	08N	04W	5
391103	820438	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	35	Shallow Alluvium	20	245	18-Jun-86	IDWR	08N	04W	8
290694	737631	[redacted]	Private	[redacted]	Payette	ID	83661	Domestic	16	Shallow Alluvium	40	310	23-Jul-97	IDWR	08N	04W	9
291011	737178	[redacted]	Private	[redacted]	Payette	ID	83661	Domestic	15	Shallow Alluvium	59	220	29-Jul-96	IDWR	08N	04W	9
388857	818189	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	20	Shallow Alluvium	46	215	8-Mar-71	IDWR	08N	04W	9
390342	819674	CHURCH OF JESUS CHRIST OF THE LATTER DAY SAINTS	Private	c/o Lou Wettstein	New Plymouth	ID	N/A	Irrigation	15	Shallow Alluvium	58	65	24-Mar-86	IDWR	08N	04W	9
429978	860648	(b) (6) [redacted]	Private	(b) (6) [redacted]	Payette	ID	83661	Domestic-Single Residence replacement well	19	Shallow Alluvium	100	360	6-Feb-11	IDWR	08N	04W	9
293534	734337	[redacted]	Private	[redacted]	Payette	ID	83661	Domestic	15	Shallow Alluvium	187	187	20-May-89	IDWR	08N	04W	10
293535	734338	[redacted] luplicit record not on graph)	Private	[redacted]	Payette	ID	83661	Domestic	15	Shallow Alluvium	187	187	20-May-89	IDWR	08N	04W	10
377306	806473	(b) (6) [redacted]	Private	[redacted]	Payette	ID	N/A	Stock	19	Shallow Alluvium	37	37	30-Dec-99	IDWR	08N	04W	10
402757	832164	[redacted] (Dry Well not on graph)	Private	[redacted]	Payette	ID	N/A	dry well	N/A	Shallow Alluvium	N/A	66	3-Nov-53	IDWR	08N	04W	10
440252	874364	GLOBAL CATHODIC PROTECTION	Private	PO Box 5189	Houston	TX	77262	Cathodic Protection	0	Shallow Alluvium	200	200	5-Feb-15	IDWR	08N	04W	10
371959	801045	(b) (6) [redacted]	Private	(b) (6) [redacted]	N/A	ID	N/A	Domestic - test	0	Shallow Alluvium	69	102	18-May-77	IDWR	08N	04W	12
292833	735167	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	7	Shallow Alluvium	38	38	26-Apr-92	IDWR	08N	04W	14
290864	737035	[redacted] og not available on line *Spoke with land owner:	Private	[redacted]	Payette	ID	N/A	Irrigation	0	Shallow Alluvium		N/A		IDWR and Land Owner	08N	04W	15
294180	734200	(b) (6) [redacted] No log available on line)	Private	(b) (6) [redacted]	N/A	ID	N/A	No log available on line	0	Shallow Alluvium	110	122	29-May-05	IDWR	08N	04W	17
294251	734271	(b) (6) [redacted]	Private	[redacted]	Payette	ID	N/A	Stock	8	Shallow Alluvium	260	260	28-Nov-88	IDWR	08N	04W	17
371958	801044	[redacted]	Private	[redacted]	Payette	ID	N/A	Stock	95	Shallow Alluvium	110	122	10-May-76	IDWR	08N	04W	17
377308	806475	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	15	Shallow Alluvium	36	200	17-Oct-65	IDWR	08N	04W	17
402781	832189	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	N/A	Shallow Alluvium	98	284	15-Nov-53	IDWR	08N	04W	17
346481	774642	[redacted]	Private	[redacted]	New Plymouth	ID	83655	Domestic	8	Shallow Alluvium		38	10-Jun-80	IDWR	08N	04W	20
432593	863475	[redacted]	Private	[redacted]	New Plymouth	ID	N/A	Domestic-Single Residence	8	Shallow Alluvium	18	80	22-May-12	IDWR	08N	04W	20
377522	806697	[redacted]	Private	[redacted]	Payette	ID	83661	Domestic-Single Residence	5	Shallow Alluvium	102	162	4-Sep-03	IDWR	08N	04W	21
292774	735110	[redacted]	Private	[redacted]	Fruitland	ID	N/A	Domestic	11	Shallow Alluvium	43	49	26-Jan-92	IDWR	08N	04W	23
371956	801042	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	12	Shallow Alluvium	32	65	2-Apr-73	IDWR	08N	04W	24
371957	801043	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	330	Shallow Alluvium	380	395	12-Oct-77	IDWR	08N	04W	24
392955	822297	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic - replacement	50	Shallow Alluvium	179	237	25-Nov-69	IDWR	08N	04W	24
444582	878927	ALTA MESA	Private	6000 Big Willow Rd	Payette	ID	83661	Domestic-Single Residence	330	Shallow Alluvium	415	415	16-May-16	IDWR	08N	04W	24
402799	832208	(b) (6) [redacted]	Private	(b) (6) [redacted]	Payette	ID	N/A	Domestic &	46	Shallow Alluvium	N/A	136	8-Jul-54	IDWR	08N	03W	19
402761	832168	[redacted]	Private	[redacted]	Payette	ID	N/A	Stock Well	125	Shallow Alluvium	N/A	198	6-Apr-65	IDWR	08N	03W	19
292830	735164	[redacted]	Private	[redacted]	Payette	ID	N/A	Domestic	4	Shallow Alluvium	80	360	10-May-92	IDWR	8N	03W	18

All Water Wells within a 1-mile radius of Proposed Aquifer Exemption Area

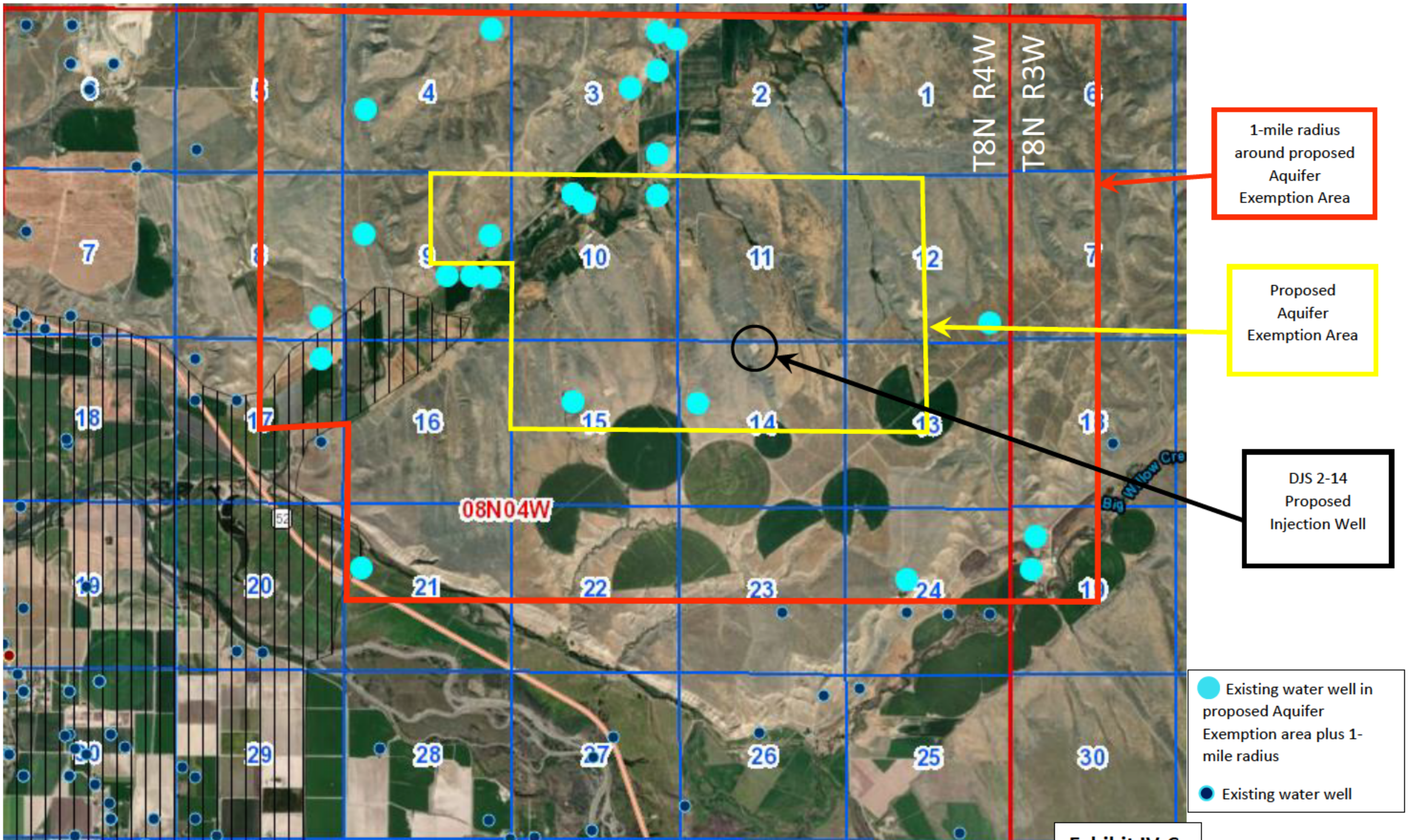

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Exhibit IV-C

Table of All Water Wells within a 1-mile radius of Proposed Aquifer Exemption Area

WellID	PermitID	Owner	Private/ Public	Contact Address	Contact City	State	Contact Zip Code	Purpose of well	Static Water Level	Name of Aquifer	Completion Data: Casing Depth	Completion Data: Total Depth	Construction Date	Source of Well Data	TWN	RGE	SEC
289347	738618	(b) (6) [redacted]	Private	(b) (6) [redacted]	Payette	ID	83661	Domestic-Single Residence	84	Shallow Alluvium	195	210	9-Dec-99	IDWR	08N	04W	3
290564	737503		Private		Payette	ID	83661	Domestic	89	Shallow Alluvium	139	185	11-May-97	IDWR	08N	04W	3
293017	735348		Private		Payette	ID	N/A	Domestic	78	Shallow Alluvium	98	240	4-Nov-92	IDWR	08N	04W	3
346482	774643		Private		New Plymouth	ID	83655	Domestic	91	Shallow Alluvium	26	185	7-Jul-80	IDWR	08N	04W	3
377199	806364		Private		Payette	ID	N/A	Domestic	80	Shallow Alluvium	169	183	17-Nov-64	IDWR	08N	04W	3
390171	819503		Private		Payette	ID	N/A	Domestic	157	Shallow Alluvium	238	245	3-Apr-85	IDWR	08N	04W	3
292325	735439		Private		Payette	ID	N/A	Domestic	8	Shallow Alluvium	22	25	22-Nov-92	IDWR	08N	04W	4
374907	804020	NEW PLYMOUTH ASSEMBLY OF GOD	Private	PO Box 107	New Plymouth	id	83655	Domestic	5	Shallow Alluvium	43.5	43	24-Jun-03	IDWR	08N	04W	4
391103	820438	(b) (6) [redacted]	Private	(b) (6) [redacted]	Payette	ID	N/A	Domestic	35	Shallow Alluvium	20	245	18-Jun-86	IDWR	08N	04W	8
290694	737631		Private		Payette	ID	83661	Domestic	16	Shallow Alluvium	40	310	23-Jul-97	IDWR	08N	04W	9
291011	737178		Private		Payette	ID	83661	Domestic	15	Shallow Alluvium	59	220	29-Jul-96	IDWR	08N	04W	9
388857	818189		Private		Payette	ID	N/A	Domestic	20	Shallow Alluvium	46	215	8-Mar-71	IDWR	08N	04W	9
390342	819674	CHURCH OF JESUS CHRIST OF THE LATTER DAY SAINTS	Private	c/o Lou Wettstein	New Plymouth	ID	N/A	Irrigation	15	Shallow Alluvium	58	65	24-Mar-86	IDWR	08N	04W	9
429978	860648	(b) (6) [redacted]	Private	(b) (6) [redacted]	Payette	ID	83661	Domestic-Single Residence replacement well	19	Shallow Alluvium	100	360	6-Feb-11	IDWR	08N	04W	9
293534	734337		Private		Payette	ID	83661	Domestic	15	Shallow Alluvium	187	187	20-May-89	IDWR	08N	04W	10
293535	734338	duplicit record not on graph)	Private		Payette	ID	83661	Domestic	15	Shallow Alluvium	187	187	20-May-89	IDWR	08N	04W	10
377306	806473	(b) (6) [redacted]	Private	(b) (6) [redacted]	Payette	ID	N/A	Stock	19	Shallow Alluvium	37	37	30-Dec-99	IDWR	08N	04W	10
402757	832164	(Dry Well not on graph)	Private		Payette	ID	N/A	dry well	N/A	Shallow Alluvium	N/A	66	3-Nov-53	IDWR	08N	04W	10
440252	874364	GLOBAL CATHODIC PROTECTION	Private	PO Box 5189	Houston	TX	77262	Cathodic Protection	0	Shallow Alluvium	200	200	5-Feb-15	IDWR	08N	04W	10
371959	801045	(b) (6) [redacted]	Private	(b) (6) [redacted]	N/A	ID	N/A	Domestic - test	0	Shallow Alluvium	69	102	18-May-77	IDWR	08N	04W	12
292833	735167		Private		Payette	ID	N/A	Domestic	7	Shallow Alluvium	38	38	26-Apr-92	IDWR	08N	04W	14
290864	737035	(log not available on line *Spoke with land owner: well does not exist)	Private		Payette	ID	N/A	No log available on line	0	Shallow Alluvium		N/A		IDWR and Land Owner	08N	04W	15
377308	806475	(b) (6) [redacted]	Private		Payette	ID	N/A	Domestic	15	Shallow Alluvium	36	200	17-Oct-65	IDWR	08N	04W	17
377522	806697		Private		Payette	ID	83661	Domestic-Single Residence	5	Shallow Alluvium	102	162	4-Sep-03	IDWR	08N	04W	21
444582	878927	ALTA MESA	Private	6000 Big Willow Rd	Payette	ID	83661	Domestic-Single Residence	330	Shallow Alluvium	415	415	16-May-16	IDWR	08N	04W	24
402799	832208	(b) (6) [redacted]	Private	(b) (6) [redacted]	Payette	ID	N/A	Domestic & Irrigation	46	Shallow Alluvium	N/A	136	8-Jul-54	IDWR	08N	03W	19
402761	832168		Private		Payette	ID	N/A	Stock Well	125	Shallow Alluvium	N/A	198	6-Apr-65	IDWR	08N	03W	19

All Water Wells within a 1-mile radius of Proposed Aquifer Exemption Area

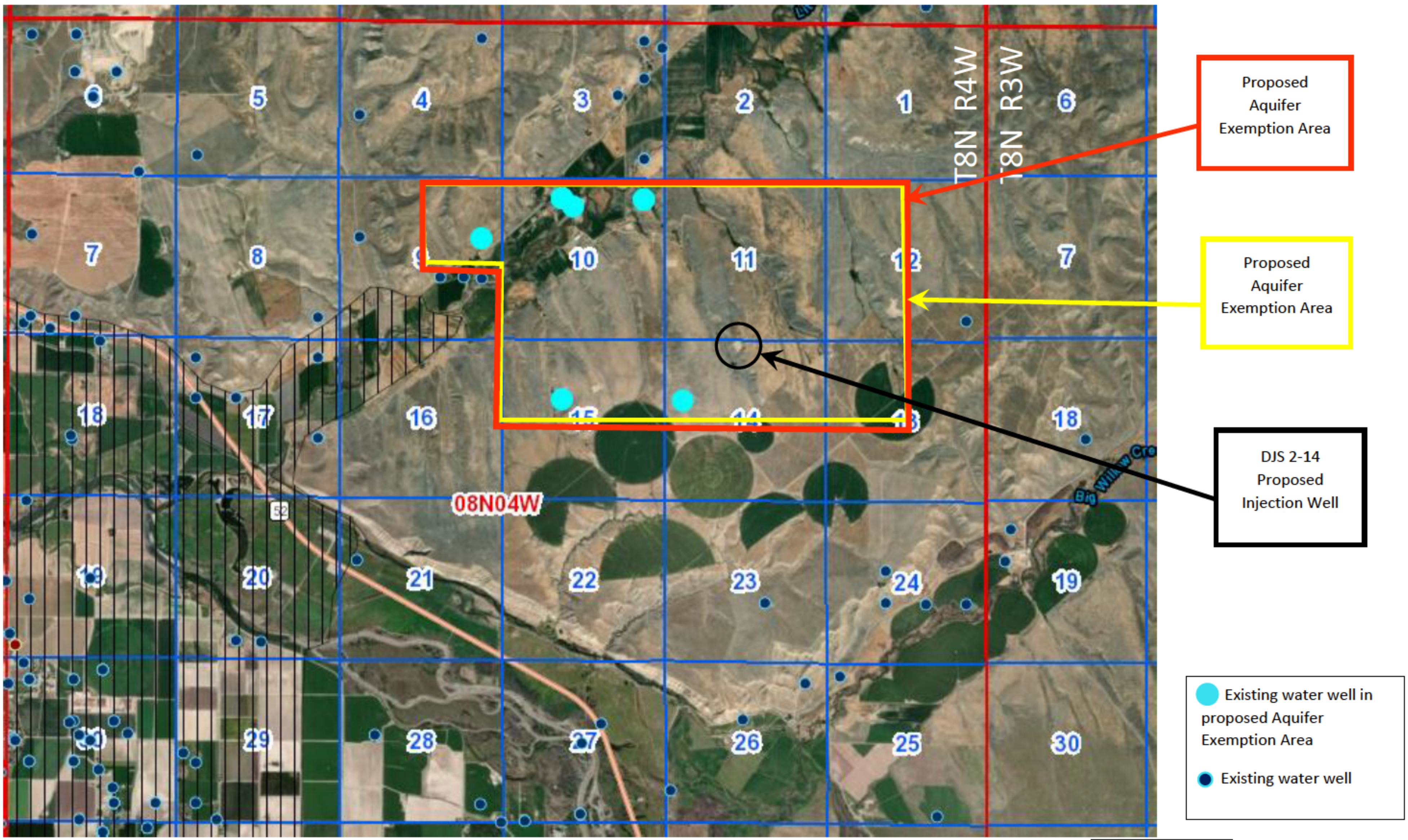


Exhibit IV-E

Table of Water Wells within Proposed Aquifer Exemption Area

WellID	PermitID	Owner	Private /Public	Contact Address	Contact City	State	Contact Zip Code	Purpose of well	Static Water Level	Name of Aquifer	Completion Data: Casing Depth	Completion Data: Total Depth	Construction Date	Source of Well Data	TWN	RGE	SEC
388857	818189	(b) (6) [redacted]	Private	(b) (6) [redacted]	Payette	ID	N/A	Domestic	20	Shallow Alluvium	46	215	8-Mar-71	IDWR	08N	04W	9
293534	734337	[redacted]	Private	[redacted] Rd	Payette	ID	83661	Domestic	15	Shallow Alluvium	187	187	20-May-89	IDWR	08N	04W	10
293535	734338	[redacted] (duplicate record)	Private	[redacted] Rd	Payette	ID	83661	Domestic	15	Shallow Alluvium	187	187	20-May-89	IDWR	08N	04W	10
377306	806473	(b) (6) [redacted]	Private	[redacted]	Payette	ID	N/A	Stock	19	Shallow Alluvium	37	37	30-Dec-99	IDWR	08N	04W	10
402757	832164	[redacted] Dry Well)	Private	[redacted]	Payette	ID	N/A	dry well	N/A	Shallow Alluvium	N/A	66	3-Nov-53	IDWR	08N	04W	10
440252	874364	GLOBAL CATHODIC PROTECTION	Private	PO Box 5189	Houston	TX	77262	Cathodic Protection	0	Shallow Alluvium	200	200	5-Feb-15	IDWR	08N	04W	10
292833	735167	(b) (6) [redacted]	Private	(b) (6) [redacted]	Payette	ID	N/A	Domestic	7	Shallow Alluvium	38	38	26-Apr-92	IDWR	08N	04W	14
290864	737035	[redacted] (log not available on line *Spoke with land owner: well does not exist)	Private	[redacted]	Payette	ID	N/A	Irrigation	0	Shallow Alluvium		N/A		IDWR and Land Owner	08N	04W	15

Exhibit IV-F

<u>The proposed injection zone within the Aquifer Exemption area is not serving as a source of drinking water:</u>

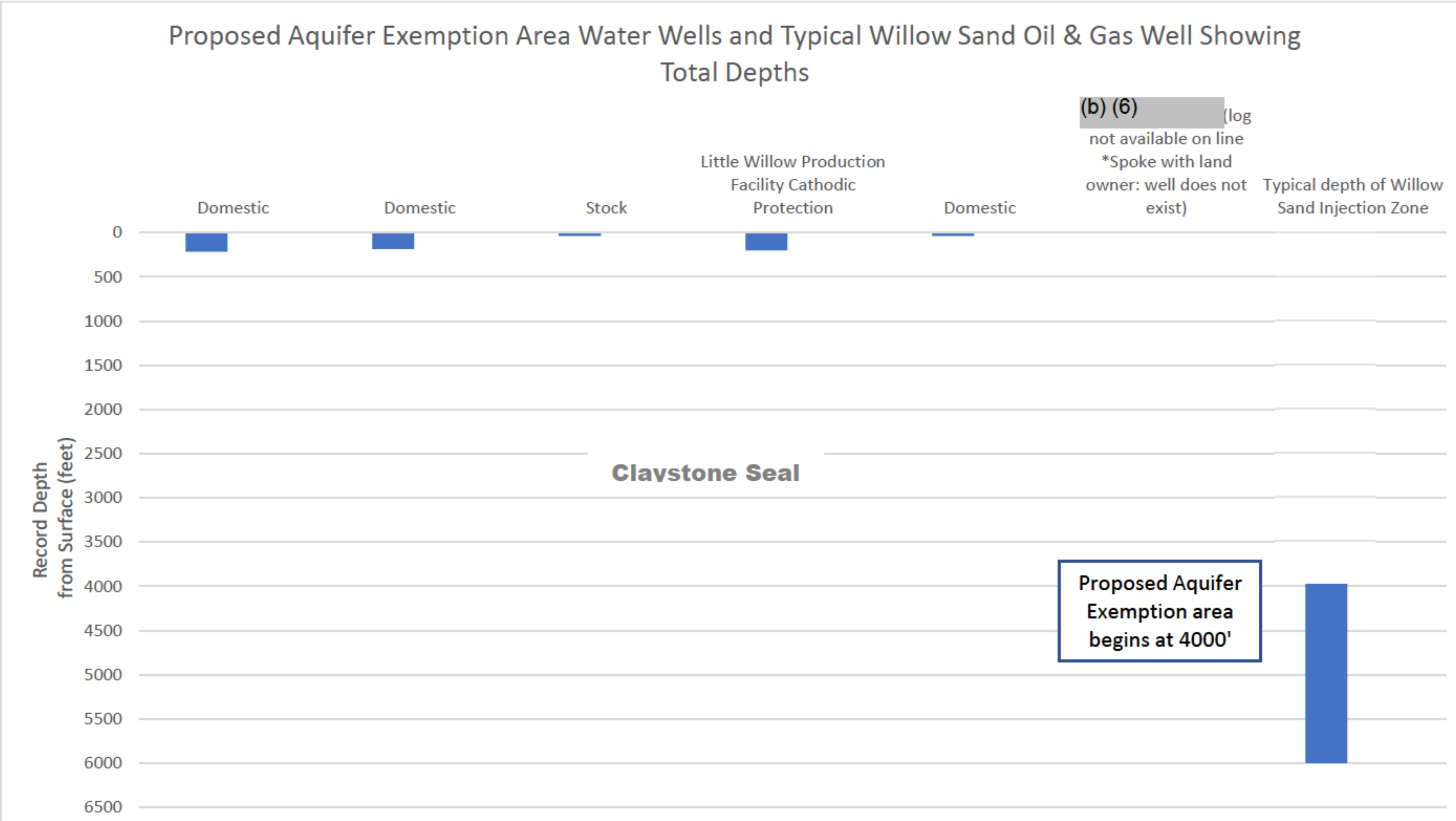
An extensive effort was made to identify all water wells within a 24-square mile area in proximity to and within the proposed Aquifer Exemption area. The three tables list all the water wells that were located within a 24 square mile area, wells within a one-mile radius area and water wells in the proposed Aquifer Exemption area as, researched using the Idaho Department of Water Resources online database.

39 water wells were found within the 24 square mile area (two wells are re-drills making the actual number of wells 37). The shallowest well was 22’ and the deepest well within the 24 square mile area was drilled to 415’.

The Willow Sand Aquifer within the proposed Aquifer Exemption area is at a depth of approximately 4000’ to 6000’ below the surface which is over 3500’ below the deepest water well (415’) in the entire evaluated 24-mile area, and is separated from the shallow aquifers with a thick layer of claystone seal.

In conclusion, the result of the water well search is that none of the 37 water wells identified in the 24 square mile search area are using water from the Willow Sand aquifer; nor is the aquifer currently serving as a source of drinking water.

* Copies of the water well reports used to compile this data are in Appendix IV.



V. Evidence supporting *40 CFR 146.4 (b)(1)*

"It cannot now and will not in the future serve as a source of drinking water because it is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible."

The Willow Sand aquifer in the Willow Field area is a commercially producing hydrocarbon reservoir. The reservoir has produced over 11.6 Billion cubic feet of natural gas, over 438,000 barrels of condensate and oil and over 17 Million gallons of natural gas liquids (NGL's) in 4 years. 9 wells have produced or are currently producing commercial quantities of hydrocarbons. First gas production from the field was sold in August of 2015. It is currently producing an average of 3.6 MMcfgd, 100 Bopd and 4500 gallons of NGL's per day from 5 wells. 4 wells are presently shut in (August 2019). 2 wells were drilled to the Willow Sands and tested noncommercial quantities of natural gas, helping to delineate the extent of the field. **Exhibit V-A** is a plot of Willow Field Historical Hydrocarbon Production.

8 wells were drilled from 2010 through 2014 to discover and delineate the field prior to first production in 2015. See **Exhibit V-B** for tables providing well names, locations, status, IP30 production rates, spud date, cumulative production and comments for each well. There are 2 sorts of the well population, one by spud date and the second sorted by well location (from north to south). IP30 is a rate metric, it is calculated as the wells *first full month* (30 days online) of total production divided by 30. This metric gives a more representative view of a wells productivity than a one day initial potential (IP) test. The comments section indicates which month and year qualified as the wells first full month of production. Note in the table that 2 wells were dually completed in the Willow Sands (Kauffman #1-9 and ML #1-11). Each of these wells has an upper tubing (UT) and lower tubing (LT) completion. The production figures for the dual completed wells are combined in this table to the respective individual well.

This information is taken from State of Idaho Monthly Production Reports. These data are collected in folders by year, and available for review in the **digital files folder** accompanying this AE request **(State of Idaho Production Reports Folder**). The information is also available online at: https://ogcc.idaho.gov/monthly-annual-reports/ Also available in the "digital files folder" is a folder entitled "Well Files- Willow Field". Within this folder are folders for each of the wells within Willow Field. Each wells folder contains the original state permit to drill, state completion reports, open hole logs and the mud log for the well.

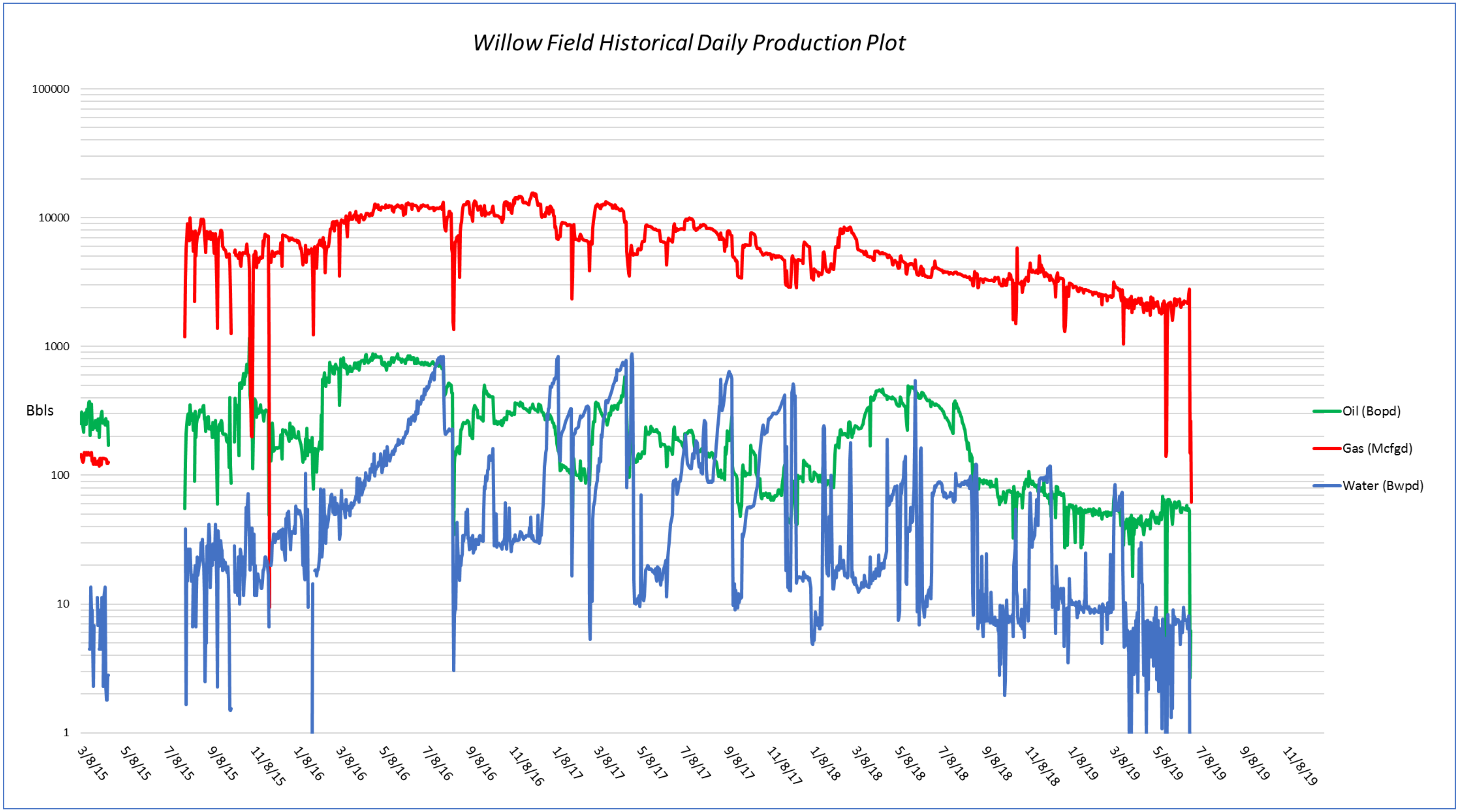

Willow Field Historical Daily Production Plot
100000
10000
1000
100
10
1
Bbls
3/8/15
5/8/15
7/8/15
9/8/15
11/8/15
1/8/16
3/8/16
5/8/16
7/8/16
9/8/16
11/8/16
1/8/17
3/8/17
5/8/17
7/8/17
9/8/17
11/8/17
1/8/18
3/8/18
5/8/18
7/8/18
9/8/18
11/8/18
1/8/19
3/8/19
5/8/19
7/8/19
9/8/19
11/8/19
Oil (Bopd)
Gas (Mcfgd)
Water (Bwpd)

Exhibit V-A

AM Idaho - Oil and Gas wells in Willow Field - Sorted by Spud Date

			IP 30 Rate (State Rpt)				Cumulative Well Production			Comments
Well	Location (Sec/TS/Rg)	Status	Oil/ Cond. (BPD)	Gas (MCFD)	Water (BPD)	Spud date	Oil/Cond (BBLS)	Gas (MCF)	Water (BBLS)	
ML 1-10	10, 8N, 4W	SI	59	1957	0	3/2/2010	6,254	266,555	1,486	Ref State Rpt August 2015 for IP 30
DJS 1-15	15, 8N, 4W	Producing	9	189	2	10/26/2010	3,702	138,394	387	Ref State Rpt February 2017 IP 30
DJS 1-14	14, 8N, 4W	Plugged	0	0	0	11/11/2010				Did not produce, uncommercial
ML 2-10	10, 8N, 4W	Producing	66	1990	9	8/1/2013	76,352	2,780,368	34,137	Ref State Rpt September 2015 IP 30
Kauffman 1-34	34, 9N, 4W	SI	41	436	0	7/22/2014	39,901	594,850	27,237	Ref State Rpt October 2015 IP 30
Kauffman 1-9 LT & UT	09, 8N, 4W	SI	175	99	16	7/31/2014	110,612	425,943	27,635	Ref State Rpt Feb 2016
ML 1-11 LT & UT	11, 8N, 4W	Producing (UT)	48	3255	9	8/27/2014	94,155	3,348,934	13,905	Ref State Rpt August 2015 IP 30
DJS 2-14	14, 8N, 4W	SI	0	0	0	9/11/2014				Tested gas - uncommercial
ML 1-3	03, 8N, 4W	SI	94	2747	0	11/28/2015	66,996	2,763,129	69,821	Ref State Rpt March 2016 IP 30
ML 2-3	03, 8N, 4W	Producing	46	1083	1.5	11/29/2015	19,671	619,624	2,471	Ref State Rpt March 2016 IP 30
ML 3-10	10, 8N, 4W	Producing	72	1931	4	11/11/2017	20,454	724,657	2,796	Ref State Rpt February 2015 IP 30
TOTAL							**438,097**	**11,662,454**	**179,875**	

*Sorted by spud date

Wells within the Aquifer Exemption Area

AM Idaho - Oil and Gas wells in Willow Field - Sorted by Location (North South)

			IP 30 Rate (State Rpt)				Cumulative Well Production			Comments
Well	Location (Sec/TS/Rg)	Status	Oil/ Cond. (BPD)	Gas (MCFD)	Water (BPD)	Spud date	Oil/Cond (BBLS)	Gas (MCF)	Water (BBLS)	
Kauffman 1-34	34, 9N, 4W	SI	41	436	0	7/22/2014	39,901	594,850	27,237	Ref State Rpt October 2015 IP 30
ML 1-3	03, 8N, 4W	SI	94	2747	0	11/28/2015	66,996	2,763,129	69,821	Ref State Rpt March 2016 IP 30
ML 2-3	03, 8N, 4W	Producing	46	1083	1.5	11/29/2015	19,671	619,624	2,471	Ref State Rpt March 2016 IP 30
Kauffman 1-9 LT & UT	09, 8N, 4W	SI	175	99	16	7/31/2014	110,612	425,943	27,635	Ref state rpt Feb 2016 IP 30
ML 1-10	10, 8N, 4W	SI	59	1957	0	3/2/2010	6,254	266,555	1,486	Ref State Rpt August 2015 for IP 30
ML 2-10	10, 8N, 4W	Producing	66	1990	9	8/1/2013	76,352	2,780,368	34,137	Ref State Rpt September 2015 IP 30
ML 3-10	10, 8N, 4W	Producing	72	1931	4	11/11/2017	20,454	724,657	2,796	Ref State Rpt February 2015 IP 30
ML 1-11 LT & UT	11, 8N, 4W	Producing (UT)	48	3255	9	8/27/2014	94,155	3,348,934	13,905	Ref State Rpt August 2015 IP 30 Note: ML 1-11 LT is currently SI
DJS 2-14	14, 8N, 4W	SI	0	0	0	9/11/2014				Tested gas - uncommercial
DJS 1-15	15, 8N, 4W	Producing	9	189	2	10/26/2010	3,702	138,394	387	Ref State Rpt February 2017 IP 30
DJS 1-14	14, 8N, 4W	Plugged	0	0	0	11/11/2010				Did not produce, uncommercial
TOTAL							**438,097**	**11,662,454**	**179,875**	

*Sorted by location, Northern wells to southern wells

Wells within the Aquifer Exemption Area

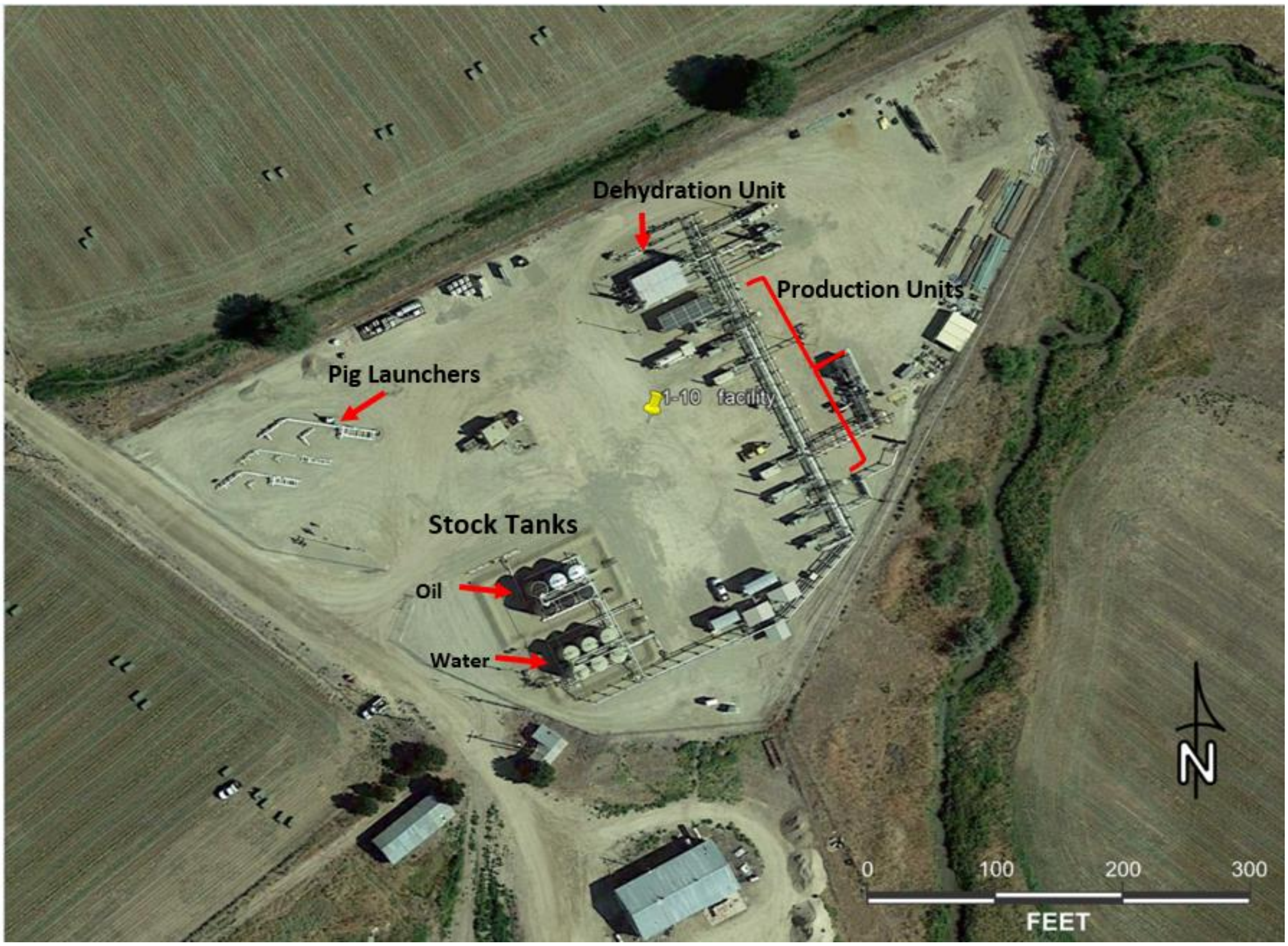
Exhibit V-B

We constructed a gathering facility (Little Willow Production Facility or LWPF) at Willow Field which collects production from the wells at Willow Field **(See Exhibits V-C and V-D).** Subsurface flowlines transport raw hydrocarbon streams from each well down to the LWPF. The produced fluids then pass through separators which separate out the natural gas, condensate, and water from each other. **Exhibit V-E** is a flow diagram of the Little Willow Production Facility. The gas is then put through a dehydration process and then into a gas pipeline. The condensate is pumped into a pipeline also. The associated produced water is collected and placed in storage tanks, and then transported by truck to an evaporative disposal facility in Kuna, Idaho.

2 pipelines 11 miles long were permitted and built from 2013 to 2015 from the Willow Field, south to an interstate gas pipeline connection. One pipeline carries gas and the other transports condensate and NGL's. These pipelines go to a midstream gas processing plant (Highway 30 Plant) which separates NGL's from the natural gas, allowing the gas to be sold into the interstate pipeline. Condensate is stabilized at the plant, which separates the NGL's from the condensate. NGL's from the gas and condensate are stored in pressurized "bullet tanks", then trucked to Ontario, Oregon, transloaded, and then transported by rail to market. Condensate is also trucked separately to Ontario, transloaded and then railed to market. Oil is transported directly from the Willow Field to Ontario for rail shipment to market. **Exhibit V-F** is a base map of the Willow Field showing the producing wells, production units and the Proposed Aquifer Exemption Area.

Google Earth Image of Little Willow Production Facility (LWPF)

MAPS OF WELL/AREA AND AREA OF REVIEW - Google Earth Image of Little Willow Production Facility (LWPF). The LWPF collects raw production via pipelines from area wells: separates oil, condensate, natural gas, and water. Storage tanks for liquids. Water is currently hauled out by truck.

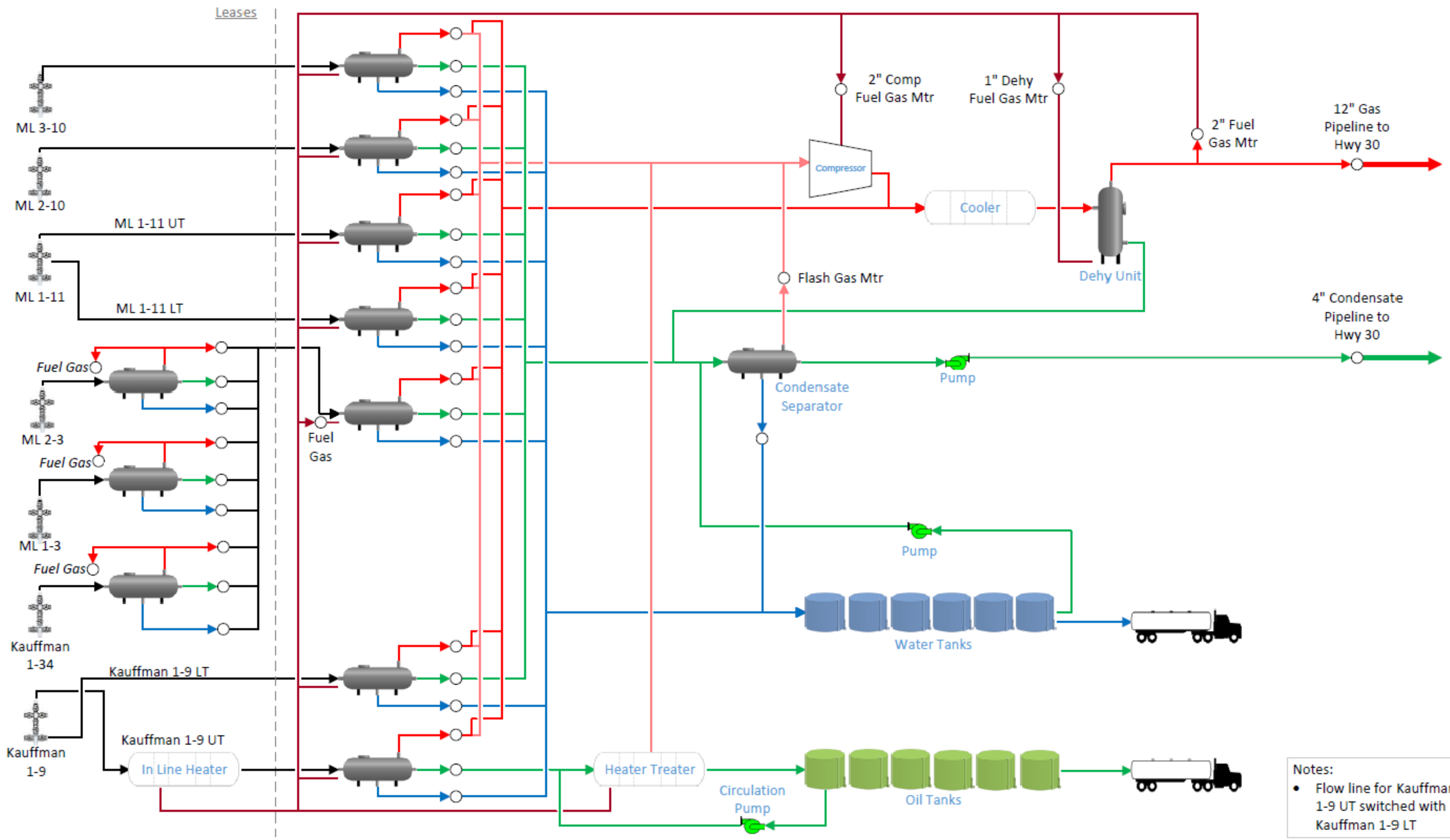


Little Willow Production Facility

ALTA MESA HOLDINGS, LP

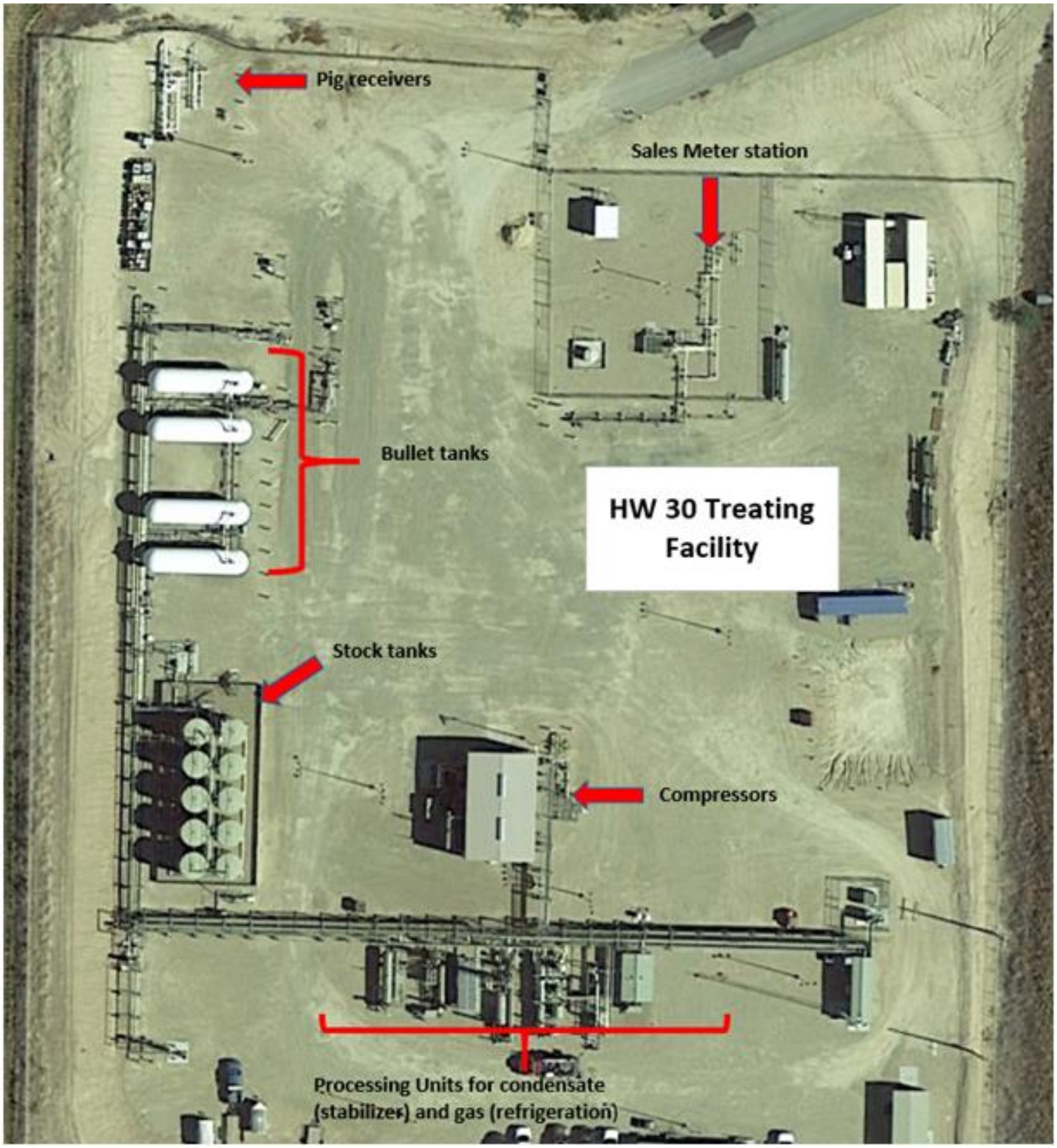
Little Willow Production Facility – Flow Diagram

03/28/2018



Notes:

- Flow line for Kauffman 1-9 UT switched with Kauffman 1-9 LT



Highway 30 Treating Facility – Midstream Operation

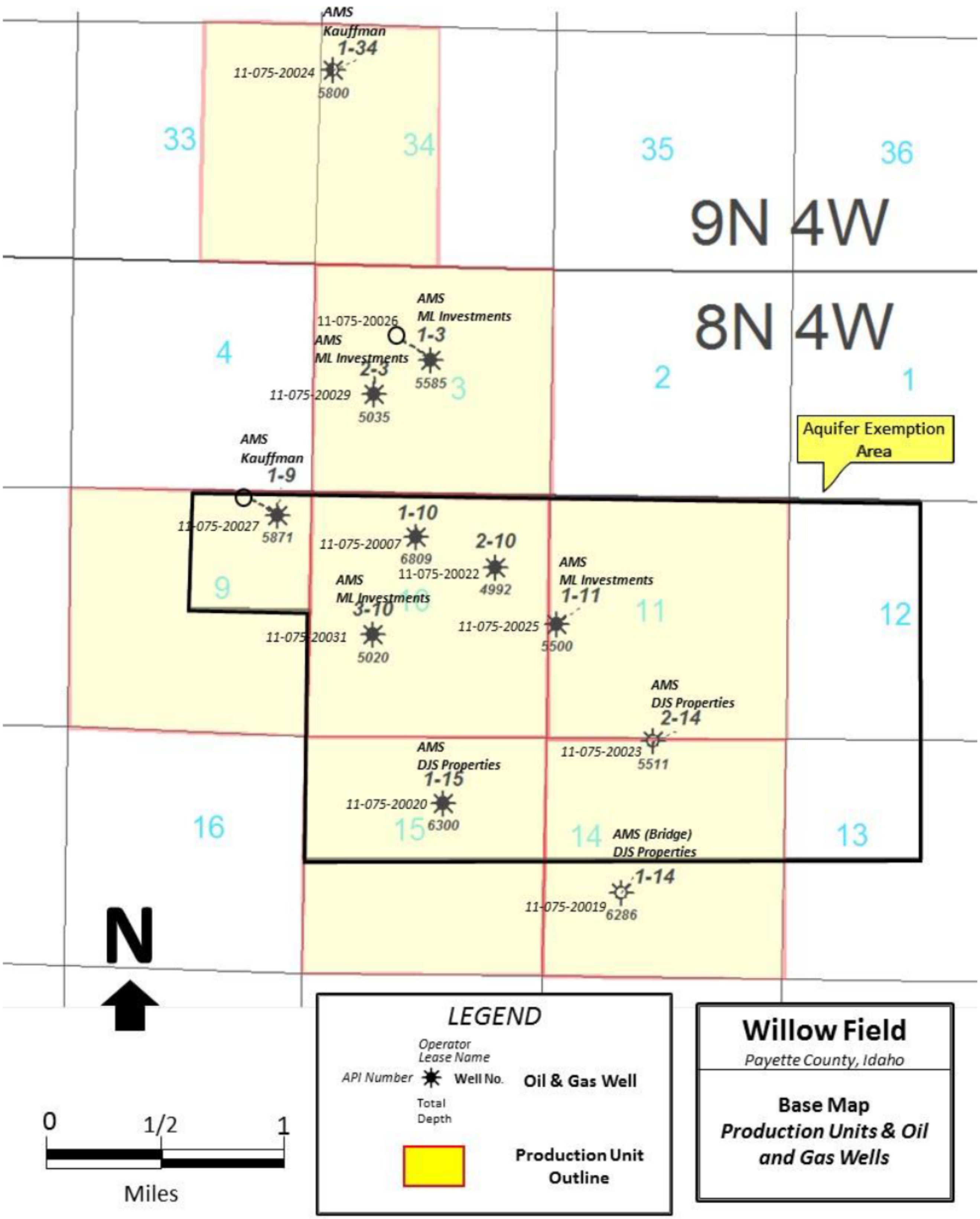

AMS
Kauffman
1-34
11-075-20024
5800
33
34
35
36
9N 4W
8N 4W
AMS
ML Investments
1-3
11-075-20026
AMS
ML Investments
2-3
5585
3
11-075-20029
5035
4
2
1
Aquifer Exemption Area
AMS
Kauffman
1-9
11-075-20027
5871
1-10
11-075-20007
6809
2-10
11-075-20022
4992
AMS
ML Investments
1-11
9
AMS
ML Investments
3-10
10
11
12
11-075-20031
5020
11-075-20025
5500
AMS
DJS Properties
2-14
11-075-20023
5511
AMS
DJS Properties
1-15
11-075-20020
6300
16
15
14
13
AMS (Bridge)
DJS Properties
1-14
11-075-20019
6286
N
0
1/2
1
Miles
LEGEND
Operator
Lease Name
API Number
Well No.
Total
Depth
Oil & Gas Well
Production Unit Outline
Willow Field
Payette County, Idaho
Base Map
Production Units & Oil and Gas Wells

Exhibit V-F

VI. Willow Field Regional Geology and Reservoir Description

The Willow Sands are a thick section of Miocene age lacustrine and fluvial sands deposited in a gradually subsiding basin. The Western Snake River Basin (WSRB) began rifting and subsiding in middle Miocene time, coincident with and following eruption of the Columbia River Basalts (17 – 12 MYA). Basalts were extruded, and volcanic ash and marsh sediments were laid down as the basin continued to subside. As the basin deepened, a lake (Lake Idaho) was formed and fluvial sands and sediment washed into and continued filling the basin. The Payette Formation and the Willow Sands member of the lower Chalk Hills formation represent these early sediments. As the basin continued to subside, drainage outlets were blocked allowing a lake of great depth (over 1000 feet in depth) to form. The middle and upper Chalk Hills formation represent this phase of deposition, it is composed of 2,000' to 3500' of claystones and ash. See **Exhibits VI-A and VI-B** modified from Barton, Idaho Geologic Survey, 2019 (pre-publication). **Exhibit VI-A** is a location map over the northeast margin of the basin. ***R-R'*** indicates a line of cross-section from near the basin margin on the east, then westerly across the Willow Field and into the basin. **Exhibit VI-B** is the regional cross-section **R-R'** which incorporates the exploratory wells drilled and demonstrates the geologic history described above. The salient points demonstrated here relative to this aquifer exemption discussion are these:

1. Thick Chalk Hills claystones provide a widespread and extremely competent top-seal above the Willow Sands.
2. The small faults present locally are early, syn-depositional and die out (cease movement) in the overlying Chalk Hills claystones.
3. The shallow aquifers in use in the basin are separated from the Willow Sands at depth by thick Chalk Hills and Glenns Ferry claystones.

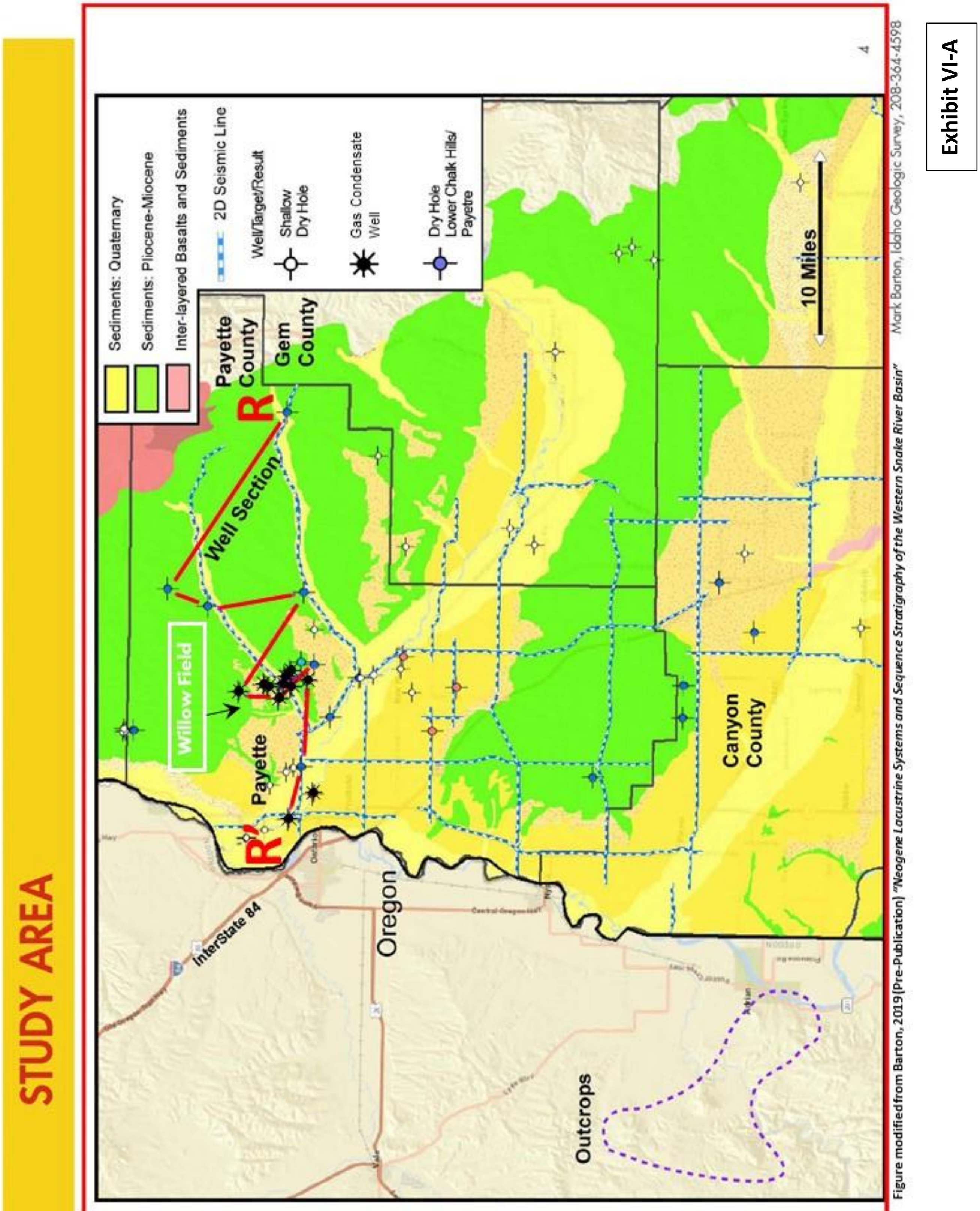


Figure modified from Barton, 2019 (Pre-Publication) *"Neogene Lacustrine Systems and Sequence Stratigraphy of the Western Snake River Basin"* Mark Barton, Idaho Geologic Survey, 208-364-4598

Exhibit VI-A

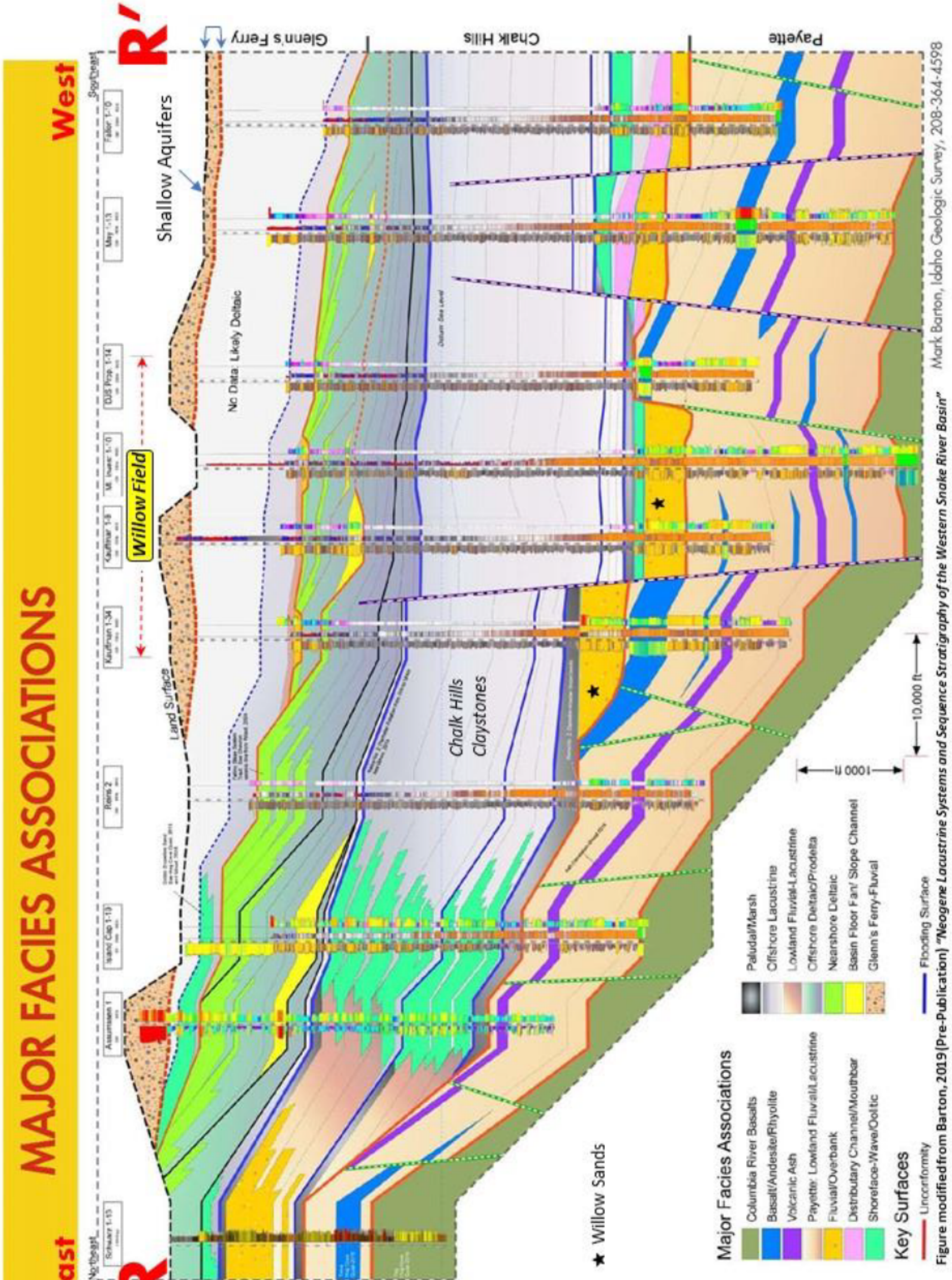


Figure modified from Barton, 2019 (Pre-Publication) *"Neogene Lacustrine Systems and Sequence Stratigraphy of the Western Snake River Basin"* Mark Barton, Idaho Geologic Survey, 208-364-4598

Exhibit VI-B

Exhibit VI-B

Exhibit VI-C is a structure map (depth subsea) of the top of the Willow Sands. The map was made using proprietary 3-D seismic data in conjunction with the sub-surface depth control provided by the numerous wells we have drilled in the Willow Field to test the Willow Sands. We designed, acquired and processed the 3-D seismic survey in 2012 specifically to image the area around the Willow Field.

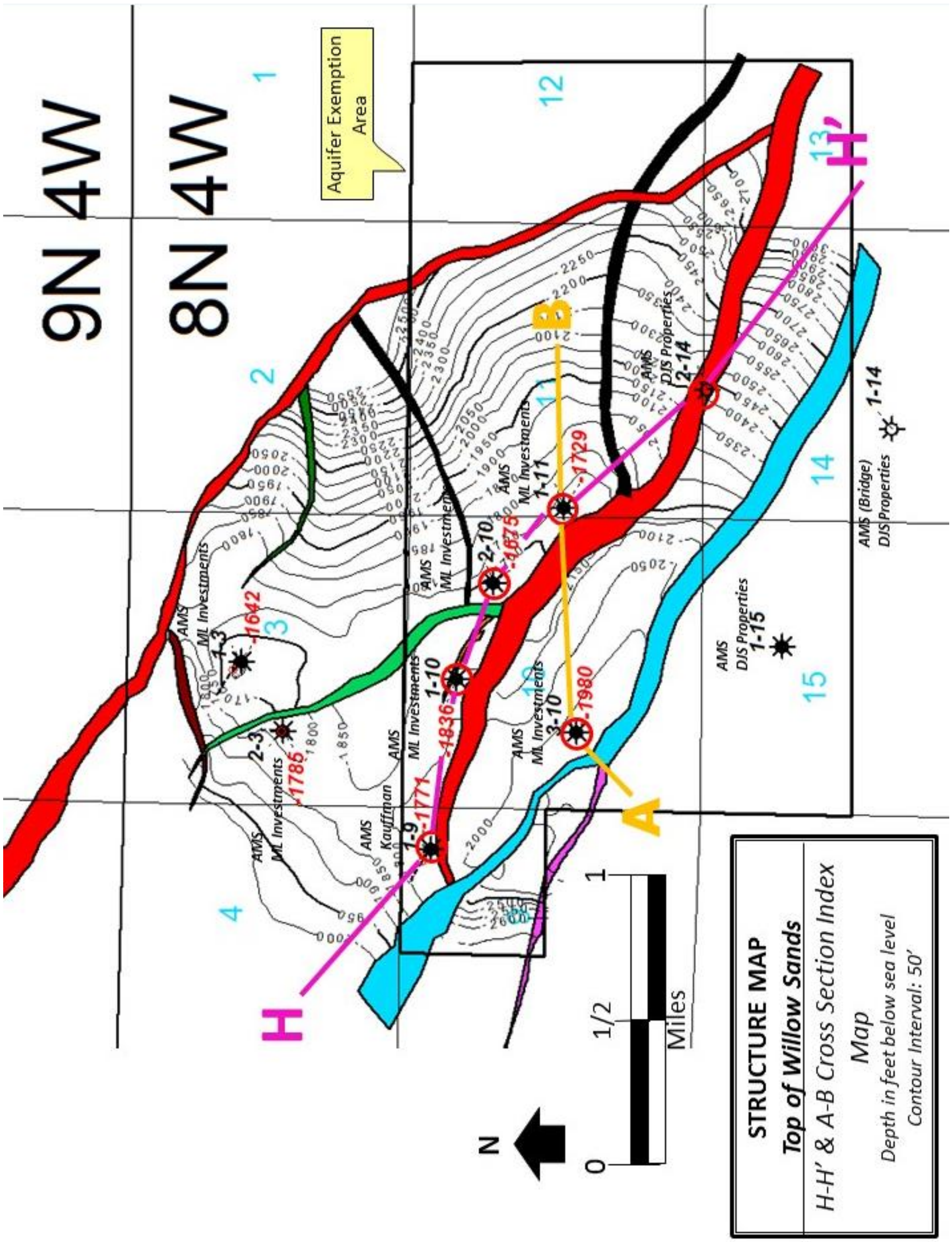
Willow Field is a roughly elliptically shaped structure about 3 miles long in a northwest-southeast axis, and 2 miles wide in a southwest-northeast direction. It is composed of several fault blocks separated by small offset buried faults (50' to 300' of throw typically at top of Willow Sand). The movement along these faults was gradual, in a dip direction, and contemporaneous with deposition. The primary evidence to identify the faults is our 3-D seismic data, and these data show the faults to have greater throw at depth, diminishing throw at the top of the Willow Sands, and then dying out and ceasing to exist by the upper Chalk Hills. The faults typically have short lateral lengths as well, usually only a half a mile long to 2 to 3 miles in length before dying out. This set of facts strongly evidences the faults to be contemporaneous depositional faults, likely related to underlying subsidence and rifting, that have had no movement for millions of years.

Exhibit VI-D is a west-east dip **cross-section A-B** of 2 wells in the Willow Field (ML #3-10 and ML #1-11), the line of section is indicated on the structure map. This cross-section will be discussed in detail in **Section VIII**, however it is presented here as an introduction to the structure and stratigraphy of the Willow Field. Note the presence of the overlying thick Chalk Hills claystone seal section, which traps gas and condensate in the Willow Sands. Also note that there are multiple thin claystone sections and ash/tuff beds interbedded within the Willow Sands. These beds provide competent and important bottom seals within the Willow Sand section.

Exhibits VI-E & VI-F are two presentations of a northwest-southeast strike **cross-section H-H'** through several wells along the structural axis of the Willow Field. **Exhibit VI-E** is the cross-section at roughly true scale (ie no vertical exaggeration) and is intended to show the entire stratigraphic succession to the surface. Note the thick, omnipresent Chalk Hills claystone section overlying the Willow Sands reservoir.

Exhibit VI-F is the same **cross-section H-H',** however displayed at 2X vertical exaggeration and focused on the Willow Sand section. This section shows the ML 1-10 well, which penetrated the entire stratigraphic section down to basalt. Note the multiple claystone layers and basal tuff and basalt layer penetrated by the ML # 1-10 well. These layers provide multiple widespread confining layers and bottom seals for the Willow Sands.

Exhibit VI-C


9N 4W
8N 4W
Aquifer Exemption Area
1
2
3
4
10
11
12
13
14
15
H
H'
A
B
AMS
ML Investments
1-3
-1642
2-3
-1785
AMS
Kauffman
1-9
-1771
1-10
-1836
2-10
-1675
AMS
ML Investments
1-11
-1729
3-10
-1980
AMS
DJS Properties
2-14
AMS (Bridge)
DJS Properties
1-14
AMS
DJS Properties
1-15
N
0
1/2
1
Miles
STRUCTURE MAP
Top of Willow Sands
H-H' & A-B Cross Section Index Map
Depth in feet below sea level
Contour Interval: 50'

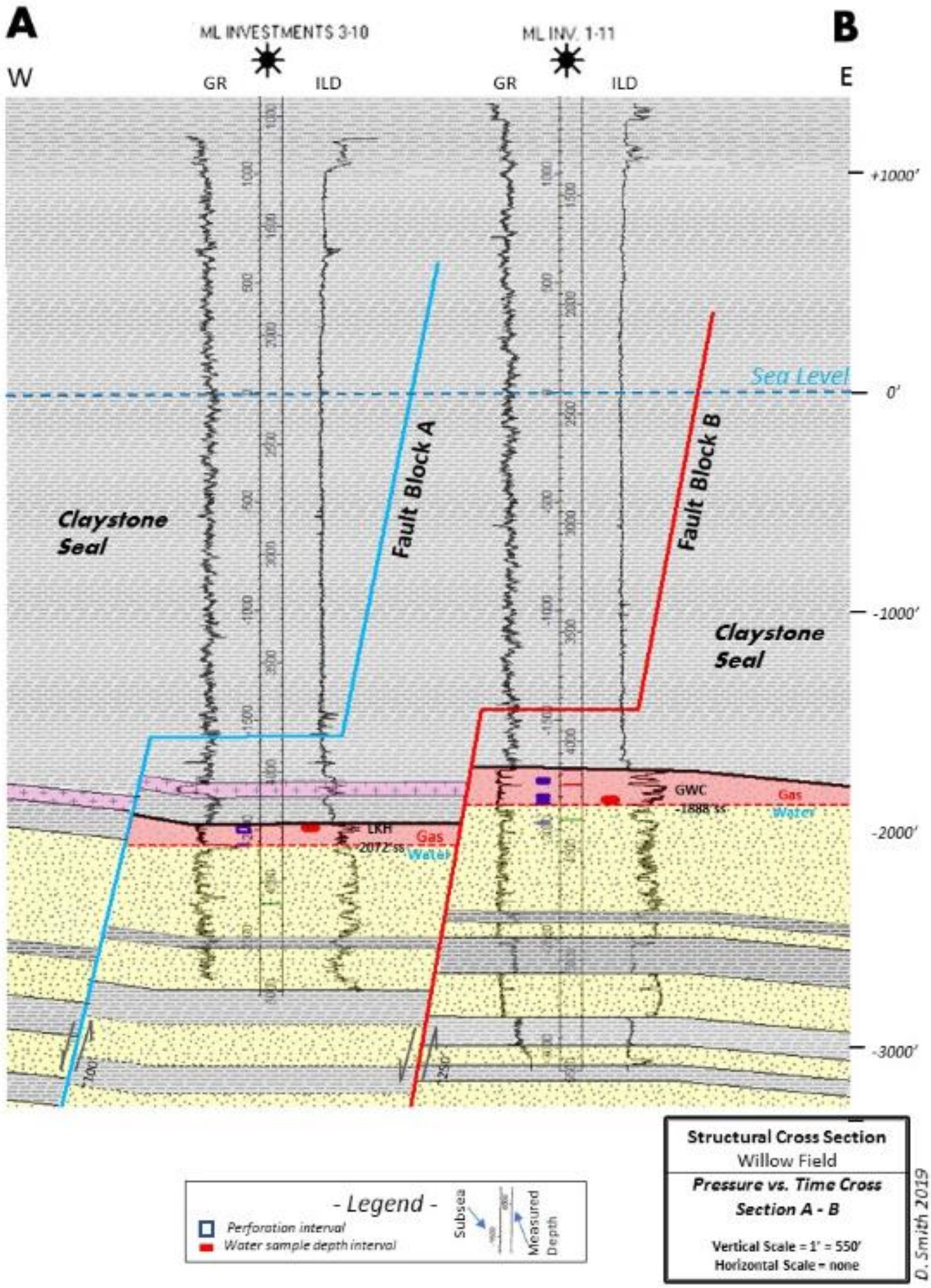

A
B
W
E
ML INVESTMENTS 3-10
ML INV. 1-11
GR
ILD
GR
ILD
+1000'
Sea Level
0'
-1000'
-2000'
-3000'
Fault Block A
Fault Block B
Claystone Seal
Claystone Seal
GWC
-1888'ss
Gas
Water
LKH
-2072'ss
Gas
Water
- Legend -
Perforation interval
Water sample depth interval
Subsea
Measured Depth
Structural Cross Section
Willow Field
Pressure vs. Time Cross Section A - B
Vertical Scale = 1" = 550'
Horizontal Scale = none
D. Smith 2019

Exhibit VI-D

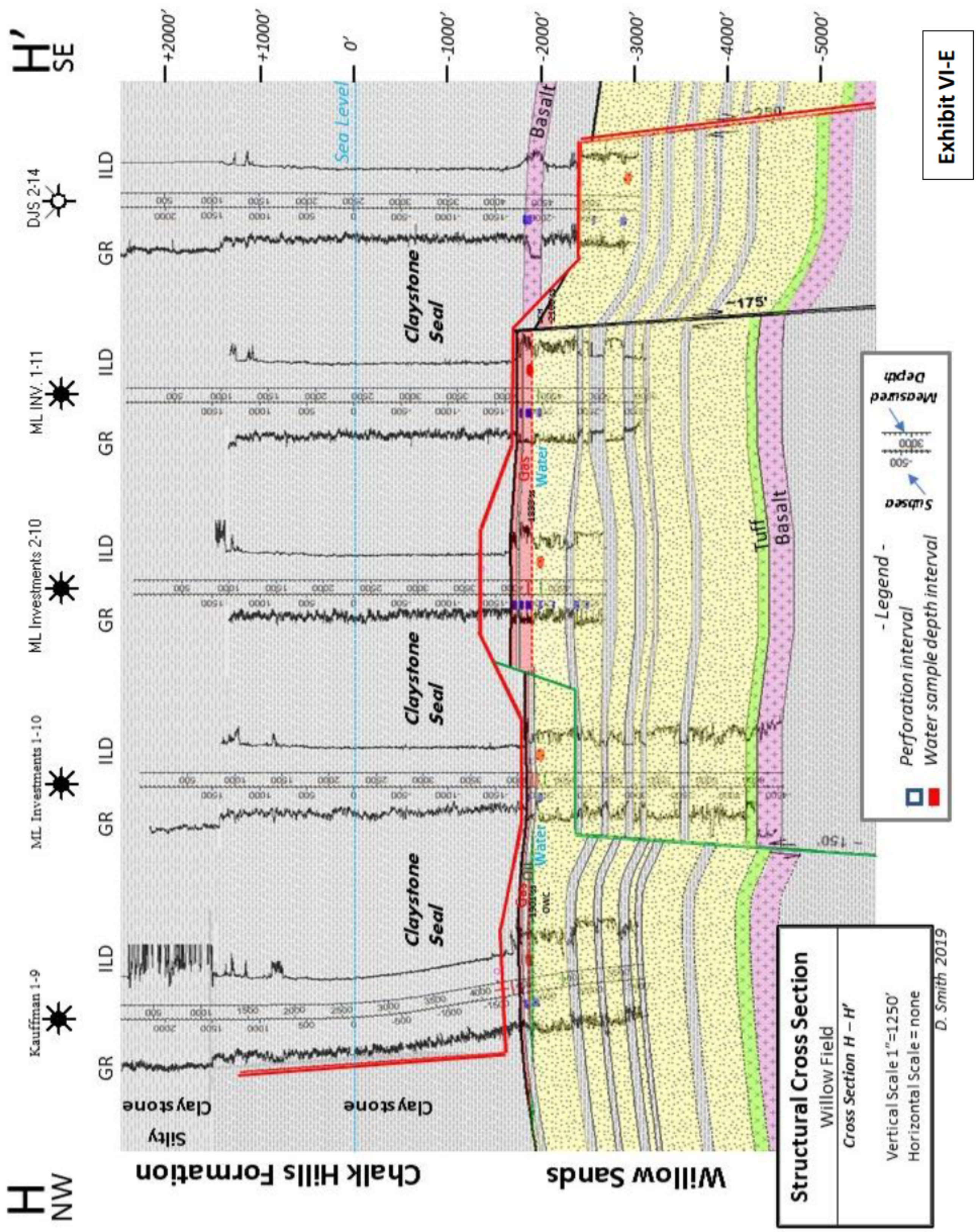

H
NW
H'
SE
Chalk Hills Formation
Willow Sands
Silty Claystone
Claystone
Kauffman 1-9
ML Investments 1-10
ML Investments 2-10
ML INV. 1-11
DJS 2-14
GR
ILD
Claystone Seal
Sea Level
Basalt
Tuff
Gas
Oil
Water
+2000'
+1000'
0'
-1000'
-2000'
-3000'
-4000'
-5000'
~175'
~250'
~150'
- Legend -
Perforation interval
Water sample depth interval
Subsea
Measured Depth
Structural Cross Section
Willow Field
Cross Section H – H'
Vertical Scale 1"=1250'
Horizontal Scale = none
D. Smith 2019
Exhibit VI-E

Exhibit VI-E

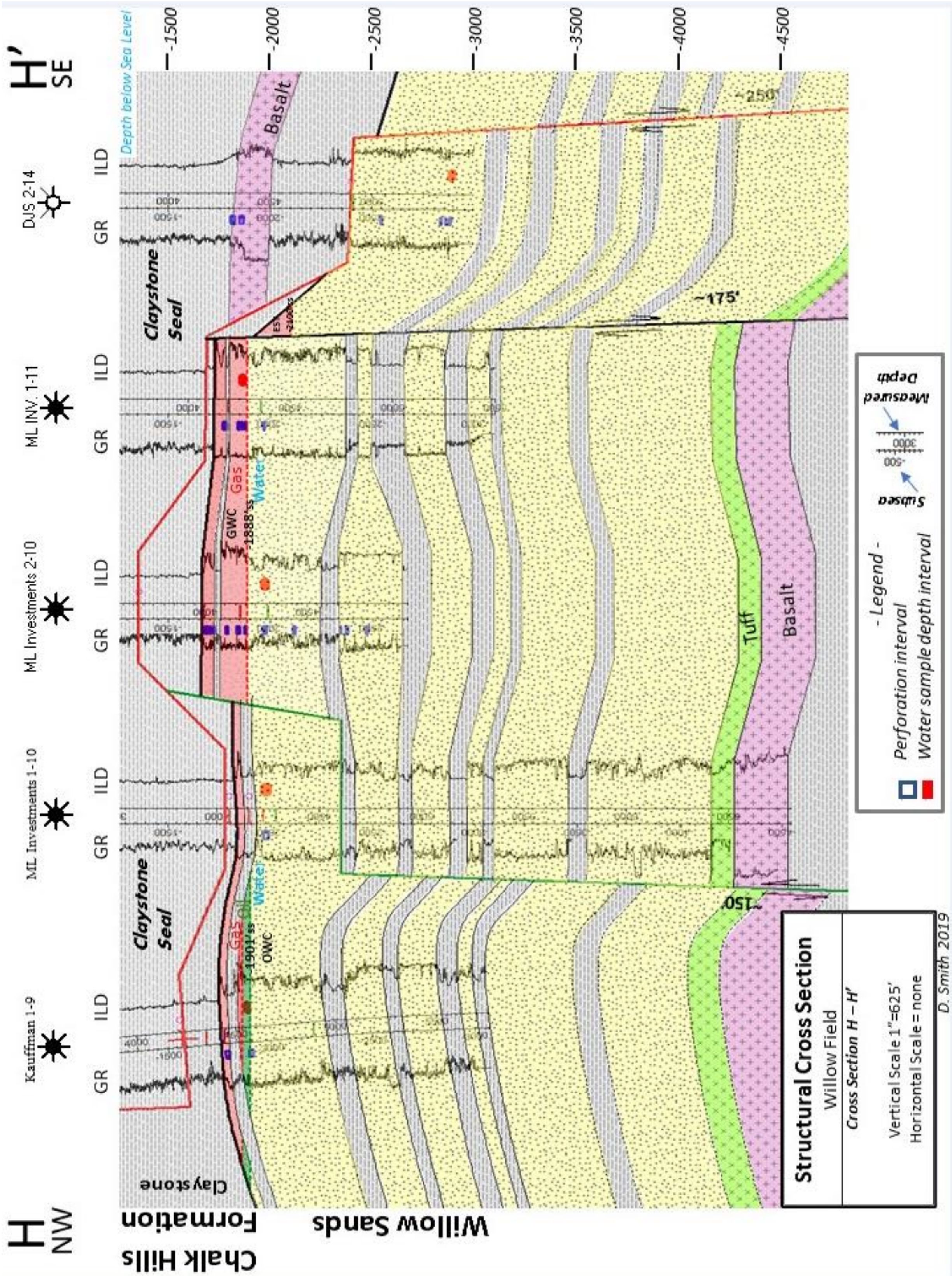

H'
SE
H
NW
Depth below Sea Level
-1500
-2000
-2500
-3000
-3500
-4000
-4500
DJS 2-14
ML INV. 1-11
ML Investments 2-10
ML Investments 1-10
Kauffman 1-9
GR
ILD
Claystone Seal
Claystone
Basalt
Tuff
Gas
Water
GWC
-1888' ss
Gas
Oil
Water
-1901' ss
OWC
~250'
~175'
~150'
Chalk Hills Formation
Willow Sands
- Legend -
Perforation interval
Water sample depth interval
Subsea
Measured Depth
Structural Cross Section
Willow Field
Cross Section H – H'
Vertical Scale 1"=625'
Horizontal Scale = none
D. Smith 2019

Exhibit VI-F

Aquifer/Reservoir Description: Willow Sands

The Willow Sands are typically massive, though often cross-bedded or laminated. They are typically sub-angular to sub-rounded and poorly sorted. This is a function of relatively short sand transport distances from their provenance in granitic highlands in central Idaho to the basin in southwest Idaho. They are dominated by abundant quartz grains, with moderate amounts of igneous rock fragments, potassium feldspars and plagioclase, and lesser amounts of biotite, metamorphic rock fragments and clays. The typically thick (50' to 200') sand beds are frequently separated by thin (5' to 50') shale, claystone, siltstone or ash/tuff beds. The cyclic nature of this deposition (Thick sand/thin claystone/thick sand/thin ash-tuff/thick sand/thin tuffaceous claystone/sand….) is consistent with the interpretation of the Willow sands representing cyclical pulses of fluvial and lacustrine sands being deposited in a lacustrine environment, with nearby volcanoes periodically producing ashfalls which wash into the lake.

We have done an extensive sidewall coring program of the wells in the field. See **Exhibit VI-G** which is a map indicating which wells (8) that we have taken sidewall cores in. We would typically take 60 to 120 sidewall cores in each of these wells. The coring program was primarily directed at evaluating the upper sections of the Willow Sands in known and suspected hydrocarbon bearing sand zones, but we have cored throughout the Willow Sand section. Porosities in the sands are typically very good, in the 25% to 34% range and permeabilities in the hundreds to thousands of millidarcies. In the digital well file folder for the ML 2-10 well is a triple combo open hole log with SWC data annotated on the log. This exhibit shows porosity and permeability values representative of the reservoir quality of the Willow Sands in the other wells that we have cored in the Willow Field.

Exhibit VI-H is an example of some of the types of petrographic analysis that we have done with cores that we have collected from the Willow Sand. This example is thin section petrography, we have also done X-ray diffraction work on some of the cores as well.

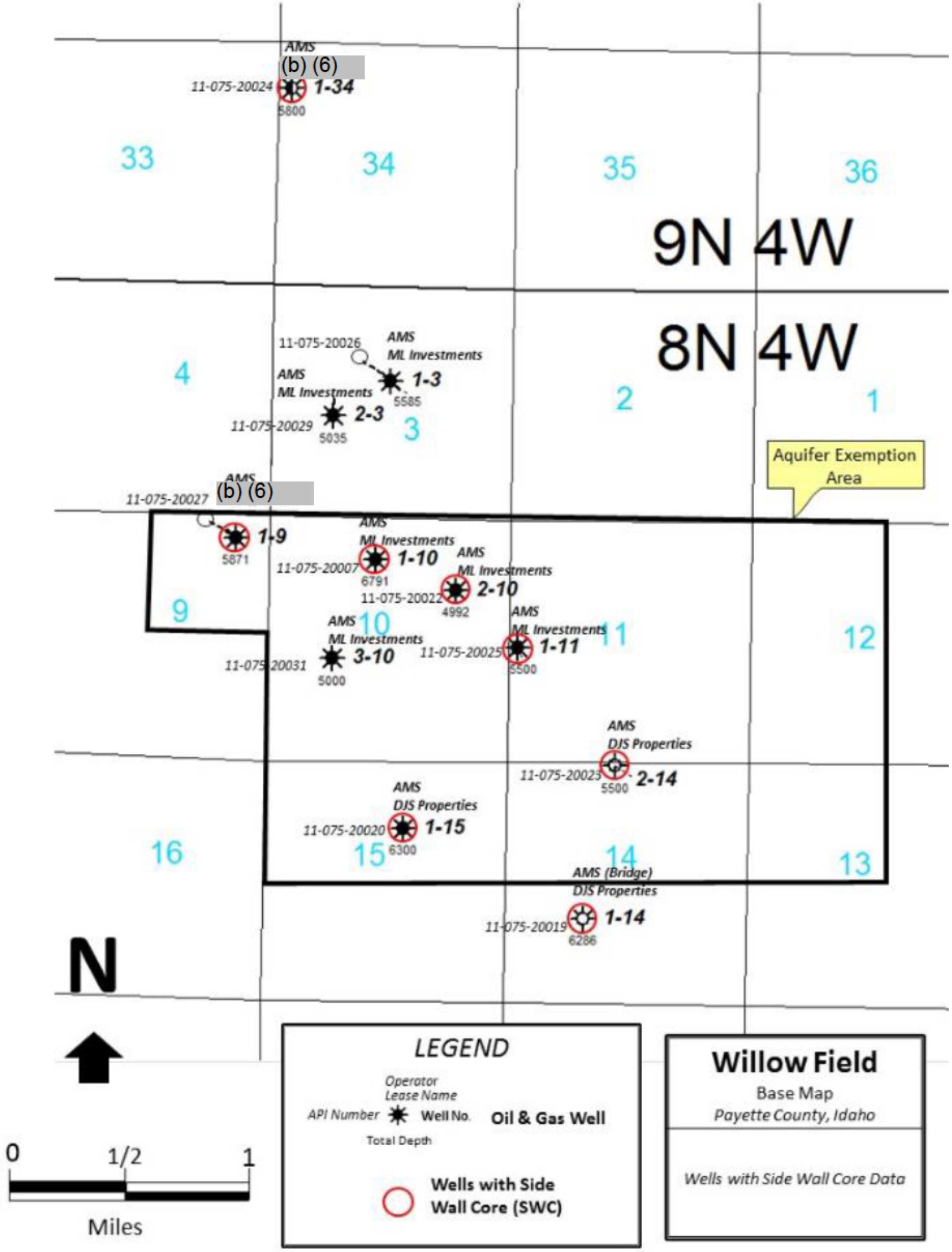

AMS
(b) (6)
11-075-20024
1-34
5800
33
34
35
36
9N 4W
8N 4W
11-075-20026
AMS
ML Investments
1-3
5585
AMS
ML Investments
2-3
11-075-20029
5035
4
3
2
1
Aquifer Exemption Area
AMS
11-075-20027
(b) (6)
1-9
5871
AMS
ML Investments
1-10
11-075-20007
6791
AMS
ML Investments
2-10
11-075-20022
4992
9
AMS
10
ML Investments
3-10
11-075-20031
5000
AMS
ML Investments
1-11
11-075-20025
5500
11
12
AMS
DJS Properties
11-075-20023
2-14
5500
AMS
DJS Properties
11-075-20020
1-15
6300
16
15
14
13
AMS (Bridge)
DJS Properties
11-075-20019
1-14
6286
N
LEGEND
Operator
Lease Name
API Number
Well No.
Total Depth
Oil & Gas Well
Wells with Side Wall Core (SWC)
Willow Field
Base Map
Payette County, Idaho
Wells with Side Wall Core Data
0
1/2
1
Miles

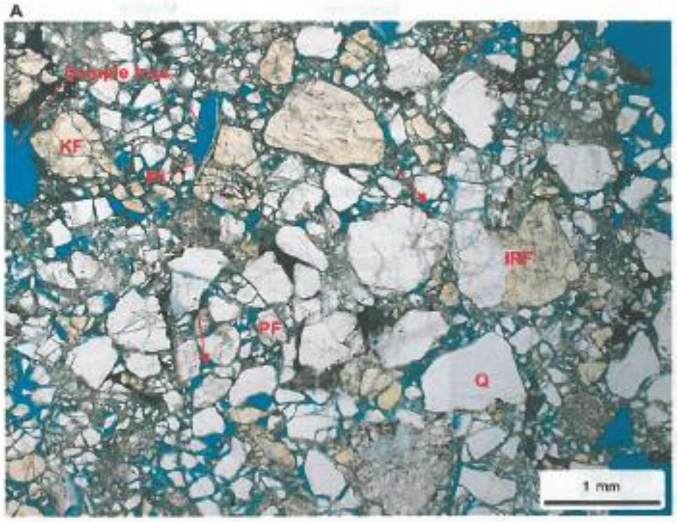
Exhibit VI-G

PLATE 3

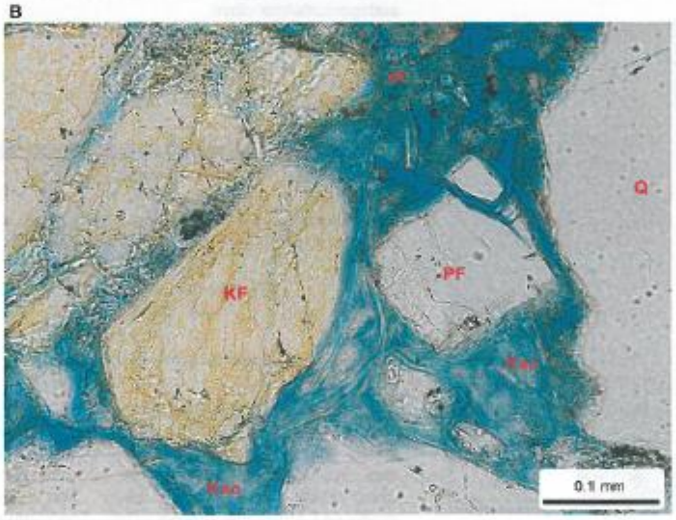
Thin Section Petrography

Company: Alta Mesa Holding
Well: Alta Mesa ML Investments 2-10
Depth (ft): 4083.0
Sample ID: 56

A



B



Relative Abundances:

Trace	<1%
Minor	1-5%
Moderate	5-10%
Common	10-20%
Abundant	>20%

LITHOLOGY AND TEXTURE

Lithology:	Sandstone
Grain Size (mm):	0.55 (Coarse sand)
Sorting:	Poor
Roundness:	Subangular-subrounded
Structures:	Massive

Framework Grains:
Abundant quartz; moderate to common igneous rock fragments, minor to moderate potassium feldspar and plagioclase; trace argillaceous and metamorphic rock fragments

Accessory Grains:
Trace micas and heavy minerals

Matrix:
Minor dispersed detrital clay matrix

Cements:
Minor kaolinite; trace pyrite, Fe-calcite and quartz overgrowths

Pore Types:
Moderate intergranular pores; minor micropores within authigenic/detrital clays

XRD-Whole Rock Mineralogy (Weight %)

Quartz	55.7	Siderite	0
K-Feldspar	20	Pyrite	0.6
Plagioclase	13.4	Laumontite	0
Calcite	0	Total Clay	10.3
Dolomite	0		
Clay Abundance (Weight %)			
Kaolinite	3.2	Illite & Mica	4
Chlorite	0.8	MXL I/S*	2.3

**Smectite in mixed-layer illite/smectite is 70-80%*

Petrographic Description

This sandstone has been heavily damaged by the sidewall coring process; most framework grains are shattered/fractured and fill intergranular areas; sample loss is locally observed. The relatively well preserved portions reveal that intergranular pores (red arrows) are probably moderate in abundance. The major pore-filling constituents are authigenic kaolinite (Kao) and detrital clay matrix (dc). The principal framework grains are quartz (Q), igneous rock fragments (IRF; mostly granite), plagioclase (PF) and K-feldspar (KF; stained yellow). Mica (Mi) is a trace accessary grain.

VII. Reservoir fluids

The primary fluids produced from the Willow Sands reservoir historically have been gas, condensate and associated fresh water. We have done extensive analyses of samples of these produced fluids at reputable, third-party commercial laboratories. This section presents the results and summaries of those analyses. **Exhibit V-B (page 27**) is a summary of the total volumes of these produced fluids.

Exhibit VII-A is an example of the results presented and constituents measured for a typical condensate sample collected from and produced by a well in the field. We have had this type of analysis done for all the producing wells in the field. The hydrocarbon liquid produced from the reservoir is a sweet, high gravity (70 degrees API), typically colorless to straw-colored condensate.

ML Investments #1-10 Condensate Analysis

PRECISION ANALYSIS

GAS MEASUREMENT EMISSIONS TESTING LABORATORY
307.856.0866
www.precision-labs.com

EXTENDED HYDROCARBON LIQUID STUDY
CERTIFICATE OF ANALYSIS

Company:	**Alta Mesa**	Sample Name:	**ML 1-10 Separator**
Pre Sample Pressure:	622 PSIG	Sample Number:	15081306-03
Post Sample Pressure:	623 PSIG	Date Tested:	08/14/2015
Field Cyliner Pressure:	623.7 PSIG	Test Method:	GPA 2186M
Lab Cylinder Pressure:	NI PSIG	Sample Location:	Idaho
Sample Pressure:	622.5 PSIG	Date Sampled:	08/10/2015
Sample Temperature:	91.5 DEG F	Date Reported:	08/20/2015
County:	NI	Note: Due to the nature of H2S, the values of H2S reported may be lower than actual.	
Sampling Method:	GPA-2174		
Type Sample:	SPOT		

Components	Mole %	Weight %	Liq. Vol. %
Hydrogen Sulfide	0.0000	0.000	0.000
Oxygen	0.0000	0.000	0.000
Carbon Dioxide	0.1186	0.072	0.055
Nitrogen	0.1010	0.039	0.030
Methane	18.8653	4.193	8.705
Ethane	5.5323	2.305	4.027
Propane	9.0136	5.507	6.759
iso-Butane	3.9344	3.168	3.504
n-Butane	8.7791	7.070	7.533
iso-Pentane	5.2147	5.213	5.191
n-Pentane	7.0274	7.025	6.933
Hexanes	5.0741	6.059	5.679
Heptanes	11.0165	15.295	13.833
Octanes	6.5950	10.438	9.196
Nonanes	2.8562	5.076	4.374
Decanes+	7.0474	17.502	14.625
Benzene	0.2568	0.278	0.195
Toluene	1.2478	1.593	1.137
Ethylbenzene	0.1799	0.265	0.189
Xylenes	0.8809	1.296	0.931
n-Hexane	5.9213	7.070	6.627
2,2,4-Trimethylpentane	0.3376	0.534	0.477
Totals	100.000	100.000	100.000

Exhibit VII-A

EXTENDED ANALYSIS DATA

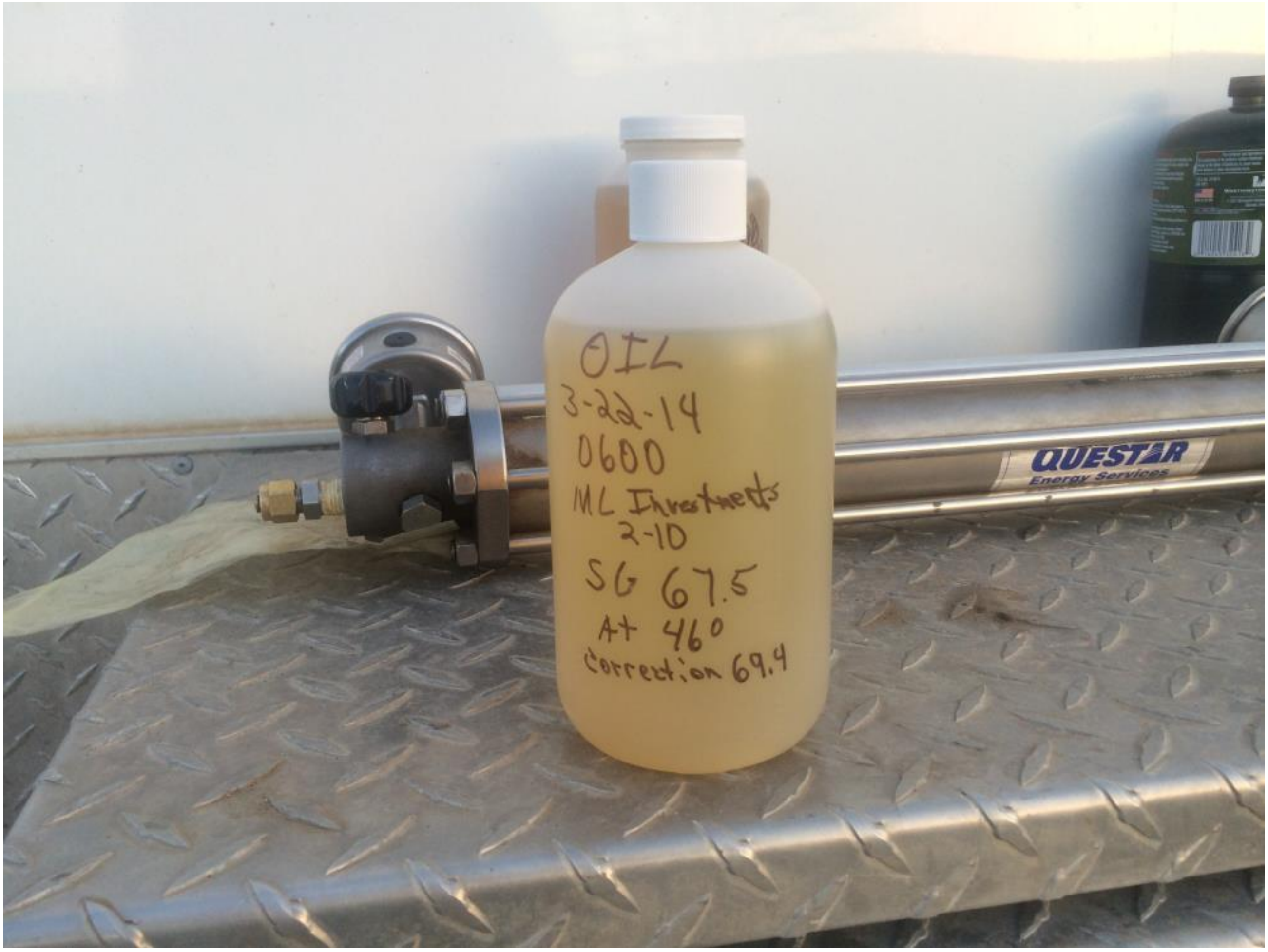
Components	Mole %	Weight %	Liq. Vol. %
Hydrogen Sulfide	0.0000	0.000	0.000
Carbon Dioxide	0.1186	0.072	0.055
Nitrogen	0.1010	0.039	0.030
Methane	18.8653	4.194	8.724
Ethane	5.5323	2.305	4.036
Propane	9.0136	5.508	6.774
iso-Butane	3.9344	3.169	3.512
n-Butane	8.7791	7.071	7.550
iso-Pentane	5.2147	5.214	5.202
n-Pentane	7.0274	7.026	6.948
Hexanes	5.0741	6.059	5.692
Heptanes	11.0165	15.297	13.864
Octanes	6.5950	10.439	9.216
Nonanes	2.8562	5.076	4.384
Decanes	2.5939	5.114	4.343
Benzene	0.2568	0.278	0.196
Toluene	1.2478	1.593	1.139
Ethylbenzene	0.1799	0.265	0.189
Xylenes	0.8809	1.296	0.933
n-Hexane	5.9213	7.071	6.642
2,2,4-Trimethylpentane	0.3376	0.534	0.478
Undecanes(C11)	1.5685	3.397	2.846
Dodecanes(C12)	0.9474	2.236	1.851
Tridecanes(C13)	0.5950	1.520	1.246
Tetradecanes(C14)	0.3443	0.947	0.769
Pentadecanes(C15)	0.2120	0.624	0.504
Hexadecanes(C16)	0.1309	0.411	0.327
Heptadecanes(C17)	0.0257	0.085	0.067
Octadecanes(C18)	0.0083	0.029	0.023
Nonadecanes(C19)	0.0552	0.206	0.158
Eicosanes (C20)	0.0524	0.205	0.162
Heneicosanes (C21)	0.0425	0.175	0.138
Docosanes (C22)	0.0438	0.189	0.151
Tricosanes (C23)	0.0326	0.147	0.115
Tetracosanes (C24)	0.0156	0.073	0.057
Pentacosanes (C25)	0.0192	0.094	0.073
Hexacosanes (C26)	0.0359	0.183	0.146
Heptacosanes (C27)	0.0568	0.299	0.240
Octacosanes (C28)	0.0244	0.133	0.103
Nonacosanes (C29)	0.0838	0.475	0.366
Triacosanes (C30)	0.0643	0.377	0.290
Hentriacontane Plus (C31+)	0.0949	0.575	0.459
Totals	100.000	100.000	100.000

ADDITIONAL BTEX DATA

Components	Mole %	Weight %	Liq. Vol. %
2-Methylpentane	3.628	4.332	4.061
3-Methylpentane	1.446	1.727	1.619
n-Hexane	5.921	7.070	6.627
2,2,4-Trimethylpentane	0.338	0.534	0.477
Benzene	0.257	0.278	0.195
Toluene	1.248	1.593	1.137
Ethylbenzene	0.180	0.265	0.189
m-Xylene	0.101	0.149	0.107
p-Xylene	0.630	0.927	0.666
o-Xylene	0.150	0.220	0.158

RELATIVE SPECIFIC GRAVITY OF DECANES+ (C10+) FRACTION, calculated	**0.74488**
AVERAGE MOLECULAR WEIGHT	**72.164**
AVERAGE MOLECULAR WEIGHT OF DECANES+ (C10+) FRACTION, calculated	**179.234**
TRUE VAPOR PRESSURE AT 100 F, PSIA, calculated	**1014.871**
AVERAGE BOILING POINT, F, calculated	**58.149**
CUBIC FEET OF GAS / GALLON OF LIQUID, as Ideal Gas, calculated	**27.752**
BTU / GALLON OF LIQUID AT 14.73 PSIA, calculated	**103,628.77**
LBS / GALLON OF LIQUID, calculated	**5.189**
BUBBLE POINT PRESSURE IN PSIG, calculated	**680.100**
BUBBLE POINT TEMPERATURE IN DEG F, calculated	**68.930**

NOTATION: ALL CALCULATIONS PERFORMED USING PHYSICAL CONSTANTS FROM GPA 2145-09, THE TABLES OF PHYSICAL CONSTANTS FOR HYDROCARBONS AND OTHER COMPOUNDS OF INTEREST TO THE NATURAL GAS INDUSTRY.



Condensate sample produced from ML 2-10

Exhibit VII-B is an example of the summary results presented from the analysis of a produced gas sample. The gas is high BTU, typically 1180-1200 per cubic foot due to the associated NGL's. This analysis with 86.2% methane, 6.2% ethane, 3.8% propane, 2 % butanes and a significant fraction of pentanes+ is typical of the natural gas produced from the Willow Sands reservoir. It also shows why a gas plant is needed to separate the NGL's from the gas stream before the gas can be sold into an interstate pipeline.

ML Investments #1-10 Gas Analysis

PRECISION ANALYSIS GAS MEASUREMENT EMISSIONS TESTING LABORATORY
307.856.0866
www.precision-labs.com

Client:	Alta Mesa Services	**Analysis Date:**	8/11/2015
Sample ID:	ML 1-10	**Date Sampled:**	8/11/2015
Unique #:	N/A	**Purpose:**	By Request
Sample Temperature:	88 DEG F	**Sample Pressure:**	598 PSI
Sampled By:	Allen McKerchie	**Type Sample:**	Spot
County:	Payettte		

Components	Mole %	Weight %	Liq. Vol. %
Carbon Dioxide............	0.1370	0.3069	0.1265
Hydrogen Sulfide..........	0.0000	0.0000	0.0000
Nitrogen......................	0.4717	0.6724	0.2807
Methane......................	86.1976	70.3591	79.0463
Ethane........................	6.2007	9.4867	8.9702
Propane.......................	3.7953	8.5153	5.6561
iso-Butane..................	0.7936	2.3469	1.4047
n-Butane.....................	1.2923	3.8218	2.2039
iso-Pentane.................	0.3480	1.2774	0.6884
n-Pentane...................	0.3514	1.2899	0.6890
Cyclopentane...............	0.0215	0.0767	0.0344
n-Hexane....................	0.1195	0.5241	0.2659
Cyclohexane................	0.0007	0.0030	0.0013
Other Hexanes	0.1141	0.5005	0.2539
Heptanes.....................	0.0485	0.2473	0.1211
Methylcyclohexane........	0.0200	0.0999	0.0435
2,2,4-Trimethylpentane...	0.0247	0.1436	0.0694
Benzene......................	0.0156	0.0620	0.0236
Toluene.......................	0.0068	0.0319	0.0123
Ethylbenzene...............	0.0023	0.0124	0.0048
Xylenes.......................	0.0039	0.0211	0.0082
C8+ Heavies................	0.0346	0.2011	0.0959
Totals	100.0000	100.0000	100.0000

ADDITIONAL BETX DATA

Components	Mole %	Weight %	Liq. Vol. %
Cyclopentane	0.0215	0.0767	0.0344
Cyclohexane	0.0007	0.0030	0.0013
2-Methylpentane	0.0718	0.3150	0.1598
3-Methylpentane	0.0423	0.1855	0.0941
n-Hexane	0.1195	0.5241	0.2659
Methylcyclohexane	0.0200	0.0999	0.0435
2,2,4-Trimethylpentane	0.0247	0.1436	0.0694
Benzene	0.0156	0.0620	0.0236
Toluene	0.0068	0.0319	0.0123
Ethylbenzene	0.0023	0.0124	0.0048
m-Xylene	0.0006	0.0033	0.0013
p-Xylene	0.0026	0.0143	0.0055
o-Xylene	0.0006	0.0035	0.0013

SPECIFIC GRAVITY @ 60/60 F, calculated...	0.6786
TOTAL GPM (Ethane Inclusive)..	3.788
CALCULATED BTU / REAL CF @ 14.73 PSIA, dry basis................................	1198.166
CALCULATED BTU / REAL CF @ 14.73 PSIA, wet basis................................	1178.078
AVERAGE MOLECULAR WEIGHT..	19.654
MOLAR MASS RATIO..	0.6786
RELATIVE DENSITY (G x Z (Air) / Z), calculated..	0.6807
IDEAL GROSS HEATING VALUE, BTU / IDEAL CF @ 14.696 PSIA..................	1191.677
COMPRESSIBILITY FACTOR (Z)..	0.99687
PROPANE GPM	1.0429
BUTANE GPM	0.6654
GASOLINE GPM (PENTANE AND HEAVIER)	0.4259
TOTAL ACID GAS MOLE %..	0.1370
H2S MOLE %	0.0000
H2S PPM	0
VOC WEIGHT FRACTION	0.192

NOTATION: ALL CALCULATIONS PERFORMED USING PHYSICAL CONSTANTS FROM GPA 2145-09, THE TABLES OF PHYSICAL CONSTANTS FOR HYDROCARBONS AND OTHER COMPOUNDS OF INTEREST TO THE NATURAL GAS INDUSTRY.

Gas flare from testing operations on ML #2-10, March 22, 2014.

Exhibit VII-C is a map entitled "Willow Sand Water Analysis". The map indicates which wells have had produced water samples analyzed. We have conducted a thorough water sampling and analysis program from the discovery, through development drilling, and into the current production phase of the life of the Willow Field. This field is the first commercial oil and gas field found in the state of Idaho, and we continue to use good scientific methodology to understand the reservoirs and their associated fluids. To understand how or if the water chemistry changes in the Willow Sand reservoir, we have attempted to have diversity in our sampling and analyses spatially, stratigraphically and temporally. The referenced map shows the spatial distribution of water samples analyzed. In the following **Section VIII** several log cross-sections are presented with stratigraphic intervals within the Willow Sands annotated that have been sampled and analyzed for water chemistry. These annotated intervals indicate stratigraphic diversity of sampling in the Willow Sands. We have collected and analyzed water samples from 2010 to 2019 as new wells were drilled and completed, as wells were recompleted into shallower zones, and some zones re-sampled once or twice after producing for an extended period.

Exhibit VII-D is a table which summarizes some of the results of the water sample analyses that we have done in the Willow Field and proposed aquifer exemption area. The table shows well name, date sampled, depth, total dissolved solids, and concentrations of Benzene, Toluene, Ethylbenzene and Xylene (BTEX). The presence of BTEX in the waters of the reservoir is unsurprising, these hydrocarbon species are normal constituents in oil, gas and condensate bearing reservoirs and those associated waters. The levels measured here in the Willow Field are well above acceptable levels for a USDW. This topic is addressed specifically in **section XI**. Full laboratory reports summarized in the table are available in **Appendix VII,** and in the digital files folder.

Water Analysis Map – Showing Wells with Water Analysis

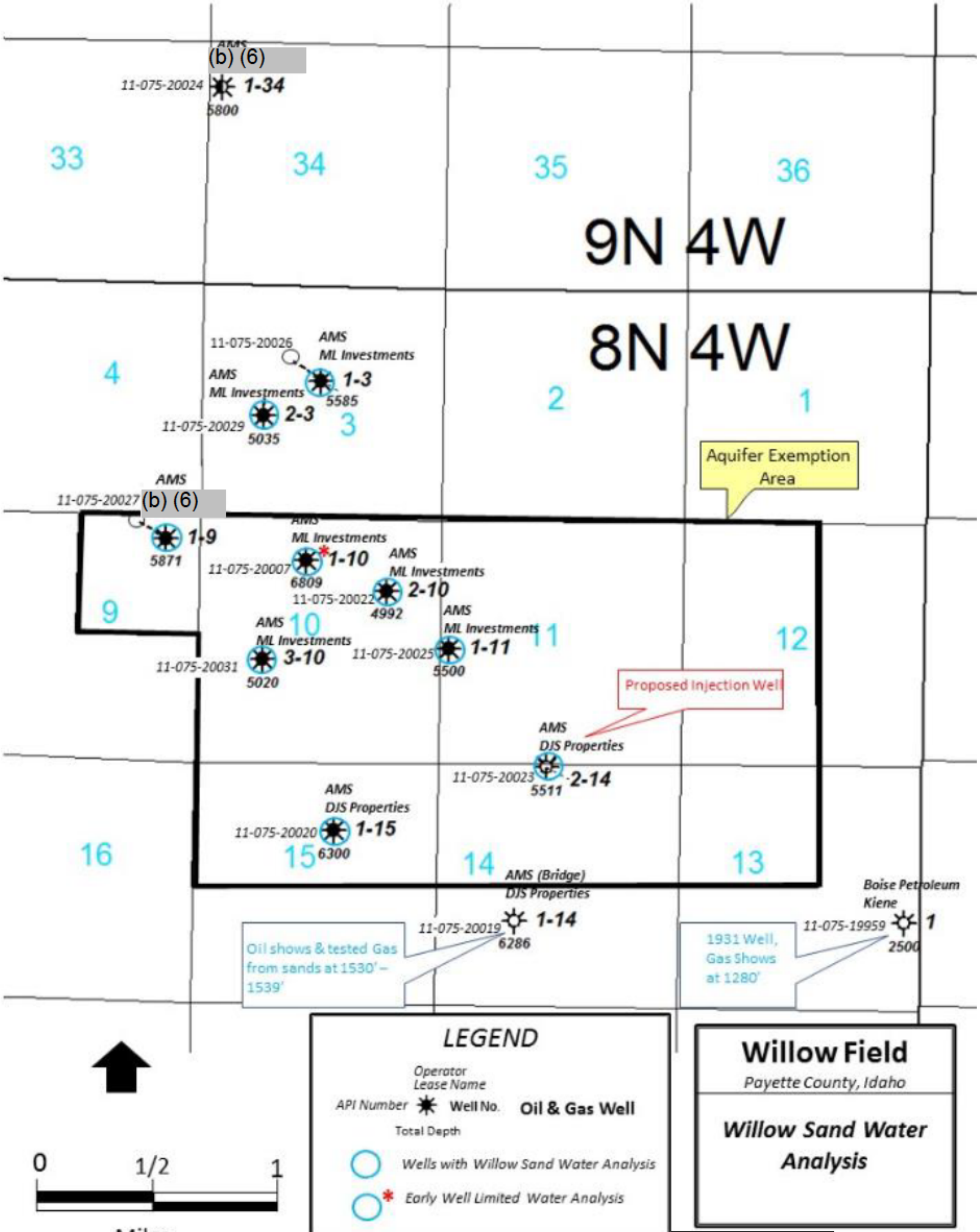


Exhibit VII-C

Water Analyses from Willow Sand Aquifer

	Date	Formation	Depth	Total Dissolved Solids (TDS)	Benzene	Toluene	Ethylbenzene	Xylene	Appendix
Well Name	**Sampled**	**Sampled**	**(MD ft)**	**(mg/L)**	**(ug/L)**	**(ug/L)**	**(ug/L)**	**(ug/L)**	
AMS DJS 2-14	10/22/2014	Willow Sand	5380	3150	1510	830	55	390	App. VII
AMS DJS 1-15	5/28/2019	U. Willow Sandy Silts	3756	1540	3030	1930	178	89	App. VII
AMS(b) (6) 1-9	3/19/2015	Willow Sand	4560	2600	2142	2335	548	661	App. VII
AMS ML Investments 1-3	5/30/2019	Willow Sand	4379	1300	775	1690	349	1800	App. VII
AMS ML Investments 1-11	10/9/2014	Willow Sand	4262	5950	8900	7800	600	3490	App. VII
AMS ML Investments 2-3	5/30/2019	Willow Sand	4462	1010	1650	2710	772	4290	App. VII
AMS ML Investments 2-10	3/20/2014	Willow Sand	4288	1650	4280	4150	425	2480	App. VII
AMS ML Investments 3-10	5/26/2019	Willow Sand	4246	510	2210	3730	1010	4460	App. VII
AMS ML Investments 1-10*	4/26/2010	Willow Sand	4225	1210	*See note below				App. VII
Sample #1	1/5/2013	Willow Sand	4096	2034	*See note below				App. VII
Sample #2	1/5/2013	Willow Sand	4096	2137	*See note below				App. VII
Sample #3	1/5/2013	Willow Sand	4096	15982	*See note below				App. VII
	2/16/2016	Willow Sand	4096	1349	*See note below				App. VII

*NOTE: ML 1-10 - A water analysis was performed for this well, but the sample was not run for BTEX. However, gas and condensate samples were pulled in which both samples showed to have concentrations of BTEX as well as other hydrocarbon components.

See ML 1-10 Gas and Condensate analysis in Appendix App. S-10 and S-11

Exhibit VII-D

Exhibit VII-E is the laboratory report for a water sample analysis from the DJS #2-14, this is an example of the typical analyses done for each water sample collected. Approximately 30 elements, compounds and hydrocarbon species are looked for and concentrations determined if present. EPA methods of analyses for each constituent are indicated in the tables. Correct sampling protocols, handling, and chain of custody procedures are practiced throughout the sampling and analysis process.

The procedure for taking and handling samples of produced water was provided by a 3rd party lab (Analytical Laboratories, Inc. in Boise, ID). The directives were very specific and detailed in the overall sampling/handling and shipping of the produced water samples. See detailed steps below:

a) Wash hands, do not touch sample bottle caps, do not rinse out bottle prior to collecting sample, use bottle supplied by Analytical Laboratories only.
b) Hold sample bottle close to water source (water dump line of separator and fill up bottle using a needle valve/spigot – Do not use hose or bucket.
c) Fill bottles until water dome forms and put cap back on. Turn bottle over and confirm there are not bubbles. If bubbles are present, carefully add more water and repeat until there are not bubbles present. Do not overflow container bottles.
d) Keep samples refrigerated – carefully place samples in cooler.
e) Fill out all paper work with each sample and mail chilled samples to Analytical Laboratories in Boise, ID.

These sample collection procedures were followed strictly; however, we would drive the samples directly to the lab in Boise in insulated coolers rather than mail them.

Analytical Laboratories, Inc.
1804 N. 33rd Street
Boise, Idaho 83703
Phone (208) 342-5515

Attn: JEFF JANIK
ALTA MESA SERVICES, LP
15021 KATY FREEWAY STE 400
HOUSTON, TX 77094

Collected By: J JANIK
Submitted By: J JANIK

Perfs 5380 - 5390'

Source of Sample:
DJS PROP 2-14 PRODUCOD WATER

Time of Collection: 16:00
Date of Collection: 10/22/2014
Date Received: 10/23/2014
Report Date: 11/7/2014

Field Temp:
PWS:
Temp Rcvd in Lab: 20.4 °C
PWS Name

Laboratory Analysis Report

Sample Number: 1442245

NO FIELD TEMP GIVEN; NO TRAVEL BLANKS RCVD; Methane, Ethane, and Ethene testing were performed by Accutest Mountain States (AMS).

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Aluminum, Al	UR	1.12	mg/L	0.10	EPA 200.7	10/24/2014	KC
Arsenic Low	0.01	< 0.005	mg/L	0.005	EPA 200.8	11/3/2014	JH
Barium, Ba	2	0.12	mg/L	0.05	EPA 200.7	10/24/2014	KC
Boron, B		7.40	mg/L	0.10	EPA 200.7	11/4/2014	KC
Calcium, Ca	UR	51.1	mg/L	0.50	EPA 200.7	10/28/2014	KC
Iron, Fe	UR	11.9	mg/L	0	EPA 200.7	10/29/2014	KC
Magnesium, Mg	UR	0.50	mg/L	0.50	EPA 200.7	10/28/2014	KC
Manganese Low		0.128	mg/L	0.005	EPA 200.7	10/24/2014	KC
Potassium, K	UR	56.7	mg/L	0.5	EPA 200.7	10/28/2014	KC
Selenium Low	0.05	< 0.005	mg/L	0.005	EPA 200.8	11/3/2014	JH
Silica	UR	106	mg/L	0.25	EPA 200.7	11/4/2014	KC
Sodium, Na	UR	392	mg/L	0.50	EPA 200.7	10/28/2014	KC
Uranium, U	30	< 5	ug/L	5	EPA 200.8	11/3/2014	JH
Metals Digestion		*			EPA 200.9-11	10/23/2014	JMS
Density		0.998	g/mL		Gravimetric	11/4/2014	JH
Nitrate (as N)		< 0.2	mg/L	0.2	EPA 300.0	10/23/2014	NC

MCL = Maximum Contamination Level
MDL = Method/Minimum Detection Limit
UR = Unregulated

Laboratory Analysis Report

Sample Number: 1442245

NO FIELD TEMP GIVEN; NO TRAVEL BLANKS RCVD; Methane, Ethane, and Ethene testing were performed by Accutest Mountain States (AMS).

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Benzene		1510	ug/L	0.5	EPA 8260B	10/28/2014	CY
Toluene		830	ug/L	0.5	EPA 8260B	10/28/2014	CY
Ethylbenzene		55.0	ug/L	0.5	EPA 8260B	10/28/2014	CY
Xylene, Total		390	ug/L	0.5	EPA 8260B	10/28/2014	CY
Methane		2.49	mg/L	0.0008	RSKSOP 175	10/27/2014	AMS
Ethane		0.399	mg/L	0.0016	RSKSOP 175	10/27/2014	AMS
Ethene		<0.0024	mg/L	0.0024	RSKSOP 175	10/27/2014	AMS
Alkalinity	UR	332	mg/L CaCO3		EPA 310.1	10/30/2014	CJS
Chloride, Cl	UR	305	mg/L	1	EPA 300.0	10/23/2014	NC
Fluoride, F	4.0	6.88	mg/L	0.10	EPA 300.0	10/23/2014	NC
Sulfate, SO4	UR	34	mg/L	1	EPA 300.0	10/23/2014	NC
pH	UR	8.8	S.U.		SM 4500-H B	10/23/2014	RME
Conductivity	UR	1,880	umhos	2	SM 2510B	10/23/2014	RME
Bicarbonate		302	mg/L		SM 2320	10/30/2014	CJS
Carbonate		29.8	mg/L		SM 2320	10/30/2014	CJS
Hydroxide		0.0	mg/L		SM 2320	10/30/2014	CJS
Resistivity		5.32	ohm*cm			10/23/2014	DS
Total Dissolved Solids	UR	1,540	mg/L	25	SM 2540C	10/28/2014	GM

MCL = Maximum Contamination Level
MDL = Method/Minimum Detection Limit
UR = Unregulated

Thank you for choosing Analytical Laboratories for your testing needs.
If you have any questions concerning this report,
please contact your client manager: James Hibbs

Page 2 of 2

Date Report Printed: 11/7/2014 11:59:12

Analytical Laboratories, Inc.
1804 N. 33rd Street
Boise, Idaho 83703
Phone (208) 342-5515

Date Report Printed: 11/21/2014 3:49:55 PM
http://www.analyticallaboratories.com
These test results relate only to the items tested.

Laboratory Analysis Report

Sample Number: 1442246

Attn: JEFF JANIK
ALTA MESA SERVICES, LP
15021 KATY FREEWAY STE 400
HOUSTON, TX 77094

Collected By: J JANIK
Submitted By: J JANIK

Source of Sample:
DJS PROP 2-14 PRODUCOD WATER

Time of Collection: 16:00
Date of Collection: 10/22/2014
Date Received: 10/23/2014
Report Date: 11/21/2014

PWS#:

Field Temp: Temp Rcvd in Lab: 20.4 °C **PWS Name:**

NO FIELD TEMP GIVEN; Radiological testing was performed by Summit Environmental (SUM).

Test Requested	MCL	Analysis Result	Units	MDL	Method	Date Completed	Analyst
Gross Alpha	15 pCi	<3	pCi/L	3	EPA 900.0	11/11/2014	SUM
Gross Beta		57+/-5.8	pCi/L	4	EPA 900.0	11/11/2014	SUM

MCL = Maximum Contamination Level
MDL = Method/Minimum Detection Limit
UR = Unregulated

Page 1 of 1

Thank you for choosing Analytical Laboratories for your testing needs.
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James Hibbs

Exhibit VII-E Cont.

CLIENT CODE=

CHAIN OF CUSTODY RECORD

ANALYTICAL LABS, INC.
1804 N. 33rd Street • Boise, ID 83703
(208) 342-5515 • Fax: (208) 342-5591 • 1-800-574-5773
Website: www.analyticallaboratories.com
E-mail: ali@analyticallaboratories.com

CLIENT INFORMATION:
Project Manager: JEFF JANIK
Company: ALTA MESA SERVICES
Address: 15021 KATY FRWY, SUITE 400
HOUSTON, TX 77094
Phone: 713.824.9427
Fax:
Sampled by: (Please print) JEFF JANIK

PROJECT INFORMATION:
Project Name: DJS PROP. 2-14
PWS Number:
Purchase Order Number:
Required Due Date:
E-mail Address: JJANIK@ALTAMESA.NET
Transported by: (Please print) JEFF JANIK

TESTS REQUESTED: FOLLOW BOTTLES

Lab ID	Date Sampled	Time Sampled	Sample Description (Source)	Sample Matrix	Remarks:
42245	8/22	4:00	PRODUCED WATER		
	8/22	4:00	"		
	8/22	4:00	"		
	8/22	4:00	"		
	8/22	4:00	"		
	8/22	4:00	"		
42246	8/22	4:00	"		CADS/Alpha/Beta
	10/22		"		
	RB		"		
			"		

Invoice to: *(If different than above address)*

Special Instructions: * NO field Temp rec'd / NO Travel Blanks rec'd

ALLOCATIONS OF RISK: Analytical Laboratories, Inc. will perform preparation and testing services, obtain findings and prepare reports in accordance with Good Laboratory Practices (GLP). If, for any reason, Analytical Laboratories, Inc. errors in the conduct of a test or procedure, their liability shall be limited to the cost of the test or procedure completed in error. Under no circumstances will Analytical Laboratories, Inc. be liable for any other cost associated with obtaining a sample or use of data.

Note: Samples are discarded 21 days after results are reported. Hazardous samples will be returned to client or disposed of at client expense.

	Print Name:	Company:	Date:	Time:
Relinquished By: *(Signature)* [signature]	JEFF JANIK	ALTA MESA SERVICES	8/23/14	9:35 AM
Received By: *(Signature)*				
Relinquished By: *(Signature)*			10/23/14	
Received By: *(Signature)* Jordyn Salyers	Jordyn Salyers	ALI	~~8/23/14~~	9:35 a.m

SAMPLE RECEIPT | Total # of Containers: 10 | Chains of Custody Seals Y / N / NA: N | Intact: Y / N / NA: N | Temperature Received: 20.4°C | Condition: *

REV. 2/19/12 | WHITE: STAYS WITH SAMPLE (S) | YELLOW: LAB | PINK: SAMPLER

Exhibit VII-E Cont.

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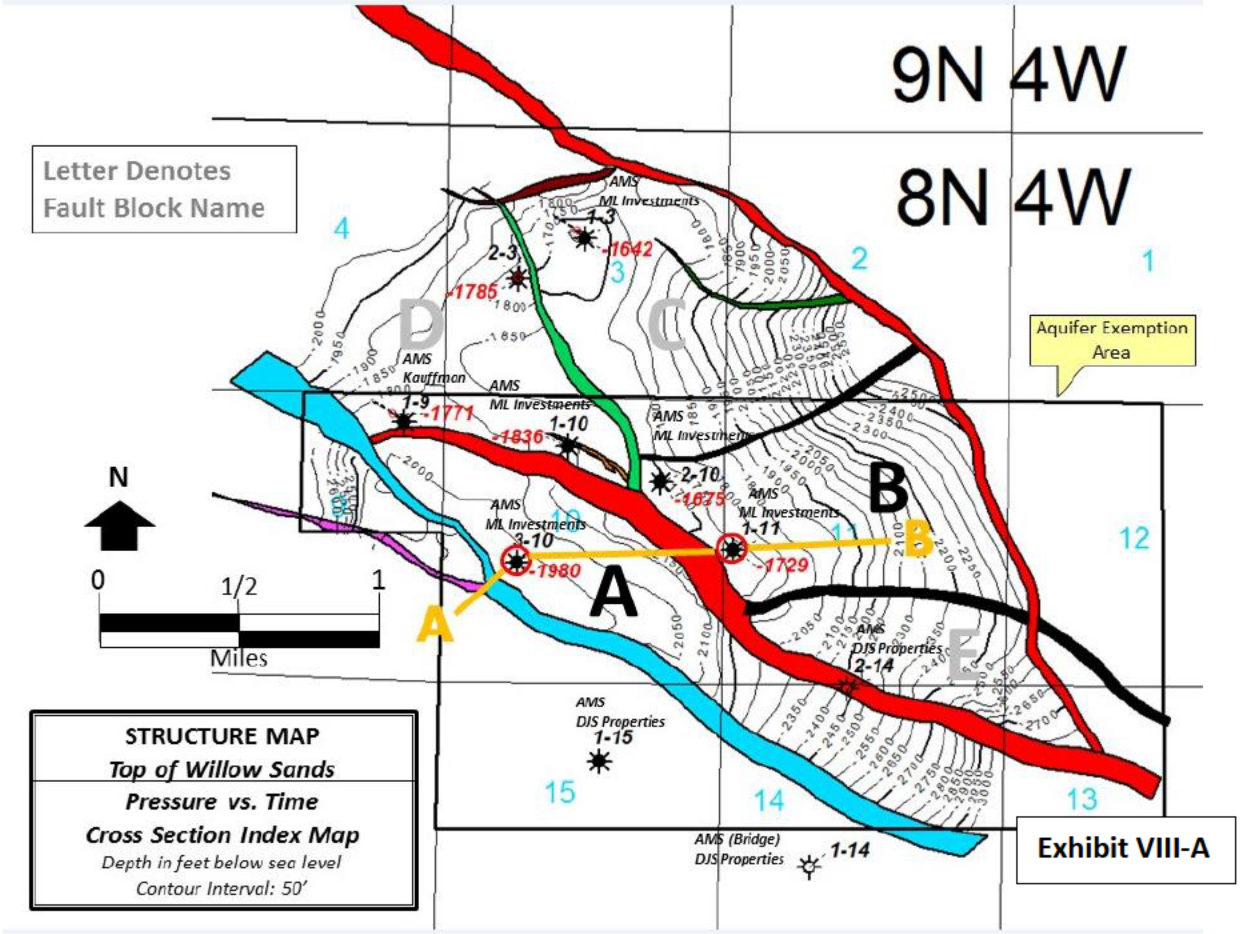
VIII. Reservoir Seal Competency

This section addresses confining zones which could serve to contain injected fluids within the Willow Sands reservoir. It is intended to examine the evidence for top seals, lateral seals and bottom seals relative to the Willow Sands reservoir. Well documented empirical evidence supports the conclusion that the Willow Sand reservoir is effectively contained by competent top, lateral and bottom seals in the fault blocks proposed to be included in the aquifer exemption request area. The evidence is presented in a series of cases following.

Top confining layer: The Willow Sands are overlain by a thick, extremely widespread layer of claystones of the lower, middle and upper Chalk Hills formation. This is capped by the Glenns Ferry formation, which is dominated by claystone, but does include minor thin sands and siltstone. The combined claystone seal layer averages over 3000 feet thick within the area of the aquifer exemption request. Log cross-sections presented previously **(Exhibits VI-B, VI-D and VI-E)** as well as additional cross-sections immediately following document this fact. The mud logs and open hole logs for the oil and gas wells drilled in the aquifer exemption area are available in the digital files folder, and available online from the state of Idaho.

Aquifer Exemption AM Idaho



Lateral Seal-Fault Seal Competency: Fault Block A and B Comparison

The structure map above displays the depth below sea level of the top of the Willow Sands. It was made utilizing 3-D seismic data and incorporating sub-surface depth control from the multiple wells we have drilled in this area that penetrate the Willow Sands. The structural cross-section **A-B** shown on the right displays the ML #3-10 well and the ML #1-11 wells, the west to east line of cross-section is indicated on the map above. The section shows the great thickness of the Willow Sands, and that hydrocarbons in the east dipping sands are trapped against claystones and basalts across the respective faults on the west. This cross-section clearly demonstrates the trapping and sealing competency of the claystones above the sands and laterally adjacent to the sands across the respective faults. If the faults and claystones were not sealing, there would be no gas and condensate trapped here.

Fault block B has 2 wells producing gas and condensate from the Willow Sands (ML #2-10 & ML #1-11), they share a common gas/water contact (GWC) of -1888' subsea. Immediately west of fault block B and downthrown across the red fault lies fault block A and the ML #3-10 well. The top of the Willow Sands in this well is at -1980' subsea, about a hundred feet lower than the GWC in fault block A (-1888'). The well is currently producing from its second completion perforations at 4246'-68' MD (-1983 to -2005' subsea.) The initial completion in the ML #3-10 tested hydrocarbons at a rate of 26 Bopd & 154 Barrels of water per day on swab from perforations at 4328'-35' MD. This depth is -2072' subsea, and establishes a lowest known hydrocarbons/water contact at -2072' subsea, nearly 200' structurally lower than the GWC in 2 wells in fault block A. Note that there is a sand on sand juxtaposition across the red fault, yet the red fault is proven to be sealing, otherwise fault blocks A and B should have common GWC's.

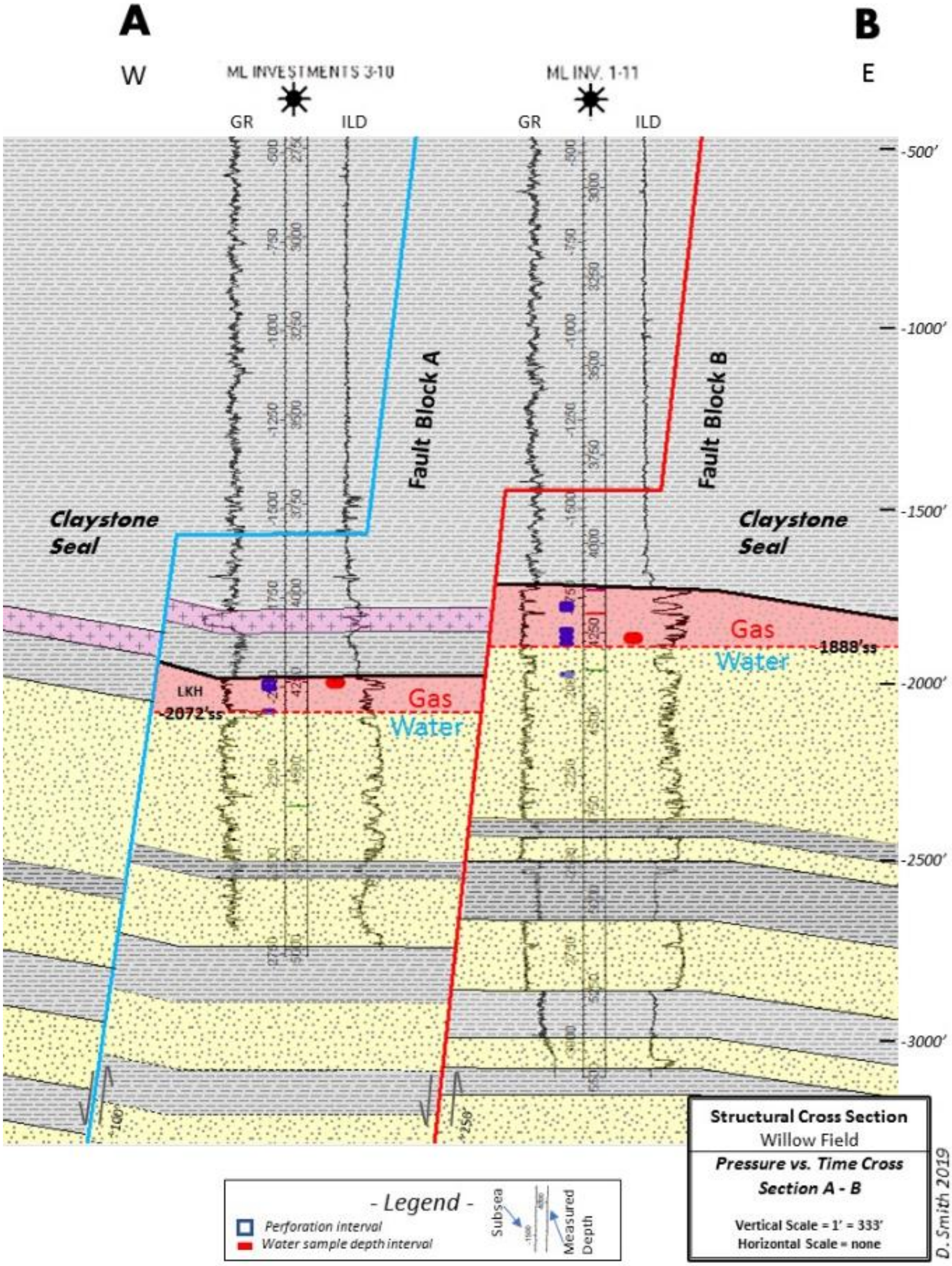
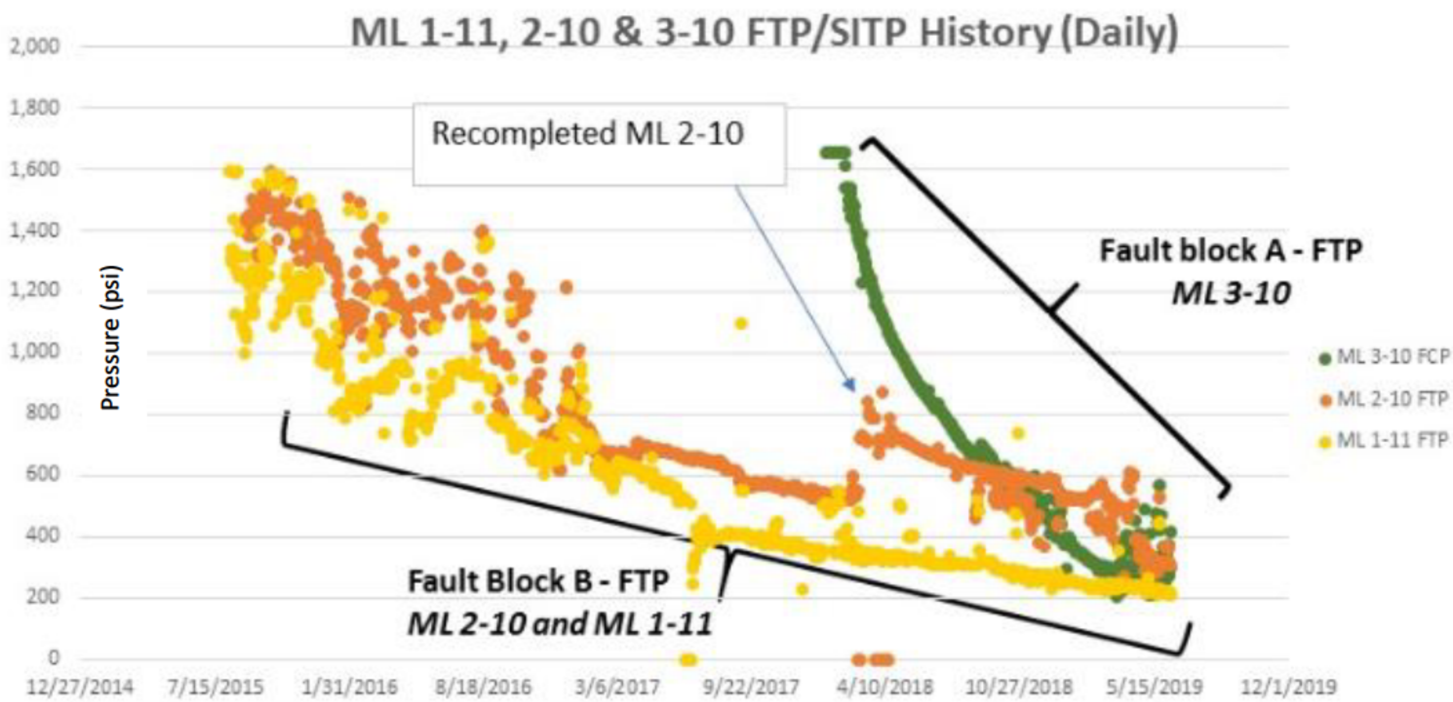


Exhibit VIII-B



The erratic pressures were due to frequent upsets with the newly constructed pipeline and midstream processing plant.

SITP - Shut in Tubing Pressure
FTP – Flowing Tubing Pressure
FCP – Flowing Casing Pressure

Exhibit VIII-C

<u>Comparing Fault block A vs Fault block B – (Comparing ML 2-10 & ML 1-11 to ML 3-10)</u>

See: Structure Map Exhibit VIII-A; Cross Section Exhibit VIII-B; and Pressure vs. time plot Exhibit VIII-C

- Pressure behavior between fault block A and fault block B suggest that the two fault blocks are isolated from each other and are not in communication.
- ML 1-11 and ML 2-10 wells are both in fault block B and were brought on line in August of 2015.
- The ML 3-10 is situated in Fault Block A, adjacent to Fault Block B and began producing in February of 2018. The ML 1-11 and ML 2-10 were both on production nearly 2 ½ years before the ML 3-10 was completed and opened to production.
- Note that the ML 3-10 Initial SITP was 1600 psig prior to opening well to production which indicates the reservoir was under virgin pressure conditions. Virgin reservoir pressure gradients run approx. 0.43 psi / ft in this area (fresh water gradient).
- If these two fault blocks were in communication, the ML 3-10 well would've been partially pressure depleted and a much lower initial SITP would've been observed when first completed.
- The drive mechanism for these two fault blocks at this depth express characteristics of a depletion drive reservoir, which is evidence of competent bottom seals as well.

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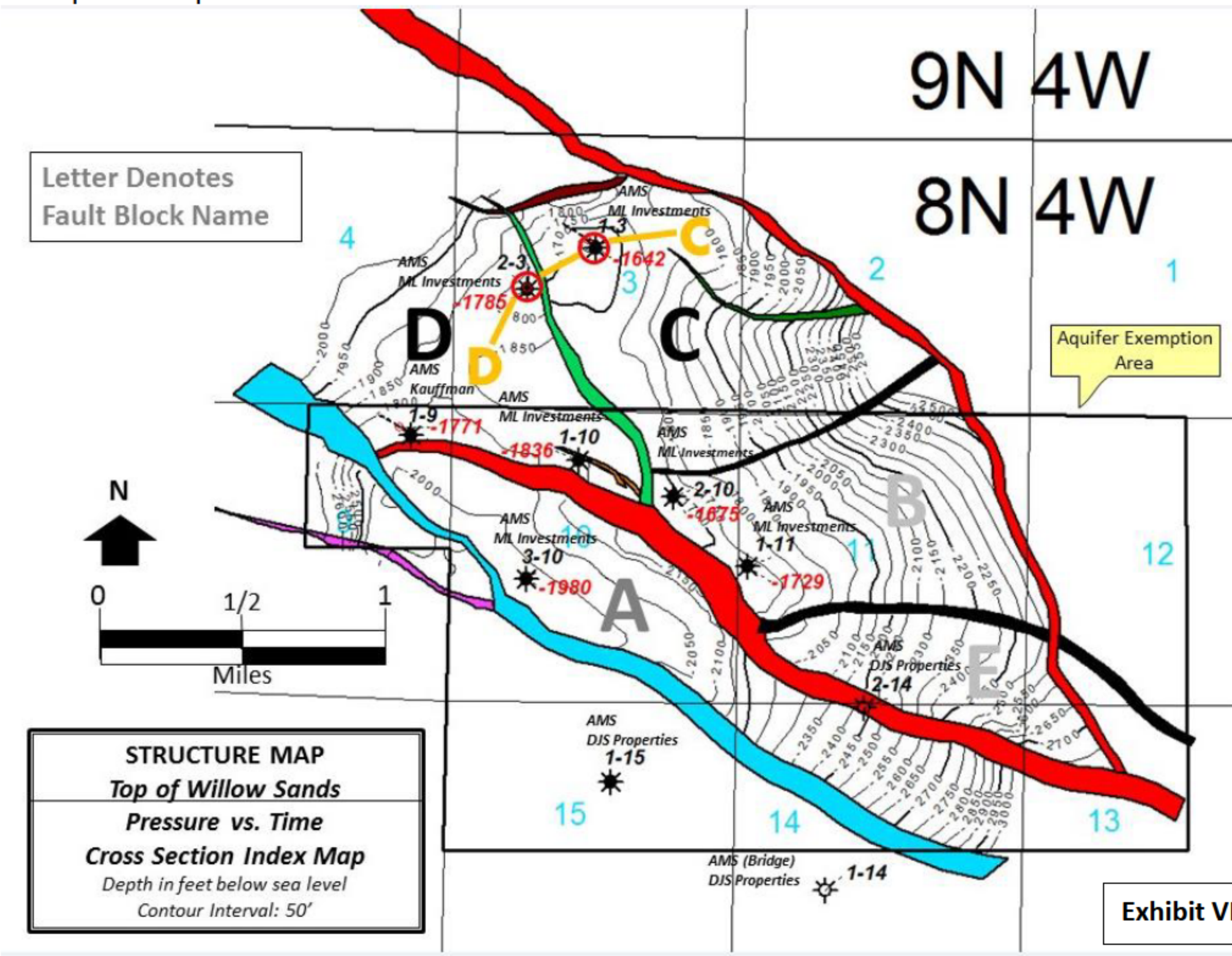


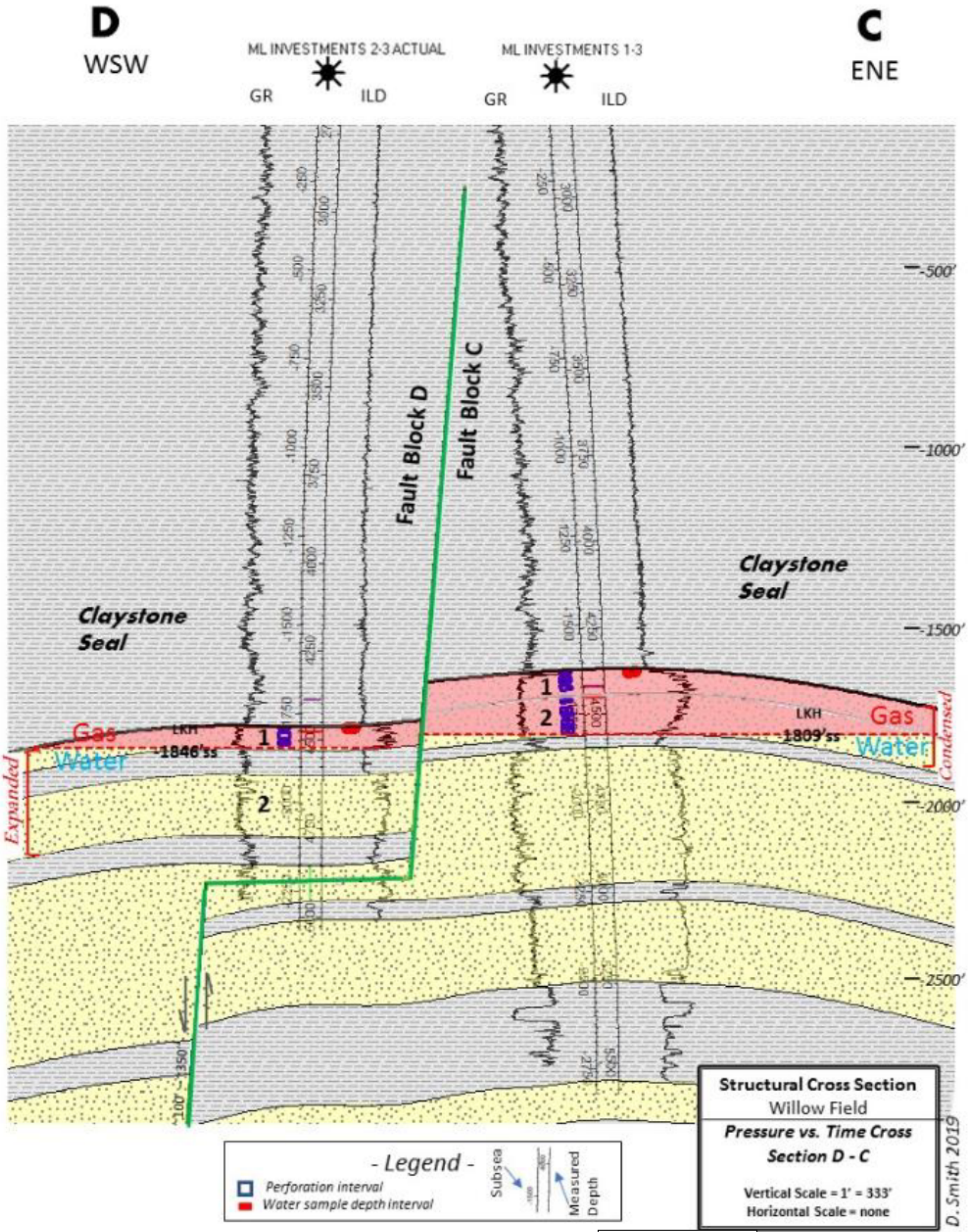
Exhibit VIII-D

Lateral Seal-Fault Seal Competency: Fault Block D and C Comparison

The structure map above is depth below sea level at the top of the Willow Sands. The structural cross-section **D-C** shown on the right displays the ML #2-3 well and the ML #1-3 wells, the west-southwest to east-northeast line of cross-section is indicated on the map above. The section shows that the top of the sand in the ML #2-3 is about 150' lower than in the ML #1-3 (-1785' versus -1636' subsea). This is due to the ML #2-3 being drilled on the downthrown side of a small down to the west contemporaneous depositional fault. This means that the fault was actively subsiding gradually in a dip direction, as the sand was being deposited. This is demonstrated by the expansion of the thickness of the "1st sand-claystone-2nd sand package" downthrown in the ML #2-3 – versus the condensed "1st sand-claystone-2nd sand package" upthrown to the fault in the ML #1-3. The contemporaneous nature of the fault is also demonstrated by it dying out at about 3000' MD, and its much greater throw at depth.

Sand 1 in the ML #2-3 is full to base with gas (4570' MD), establishing LKH @ -1846' subsea. In the ML #1-3 sands 1 and 2 are full to base with gas (4560' MD), establishing LKH @ -1809' subsea. The ML #1-3 was initially completed in the base of sand 2 and produced at 1.9 MMcfgd and 24 Bopd with no water. It has been plugged back and recompleted higher several times as the water production would increase. It has produced 2.76 Bcfg, about 67,000 Bbls of condensate and 70,000 Bbls of water (August 2019). We currently are completed in the very top of the sand, and produce the well intermittently as gas builds up in this strong water drive reservoir.

The ML #2-3 is still producing at around 1.6 MMcfgd (Aug. 2019) even though it is 150' structurally low to the ML #1-3. This behavior demonstrates that the green fault is a competent lateral seal between fault blocks D and C.



D
WSW
C
ENE
ML INVESTMENTS 2-3 ACTUAL
ML INVESTMENTS 1-3
GR
ILD
GR
ILD
Fault Block D
Fault Block C
Claystone Seal
Claystone Seal
Gas
Water
LKH
-1846'ss
LKH
-1809'ss
Gas
Water
Expanded
Condensed
1
2
1
2
-500'
-1000'
-1500'
-2000'
-2500'
- Legend -
Perforation interval
Water sample depth interval
Subsea
Measured Depth
Structural Cross Section
Willow Field
Pressure vs. Time Cross Section D - C
Vertical Scale = 1' = 333'
Horizontal Scale = none
D. Smith 2019

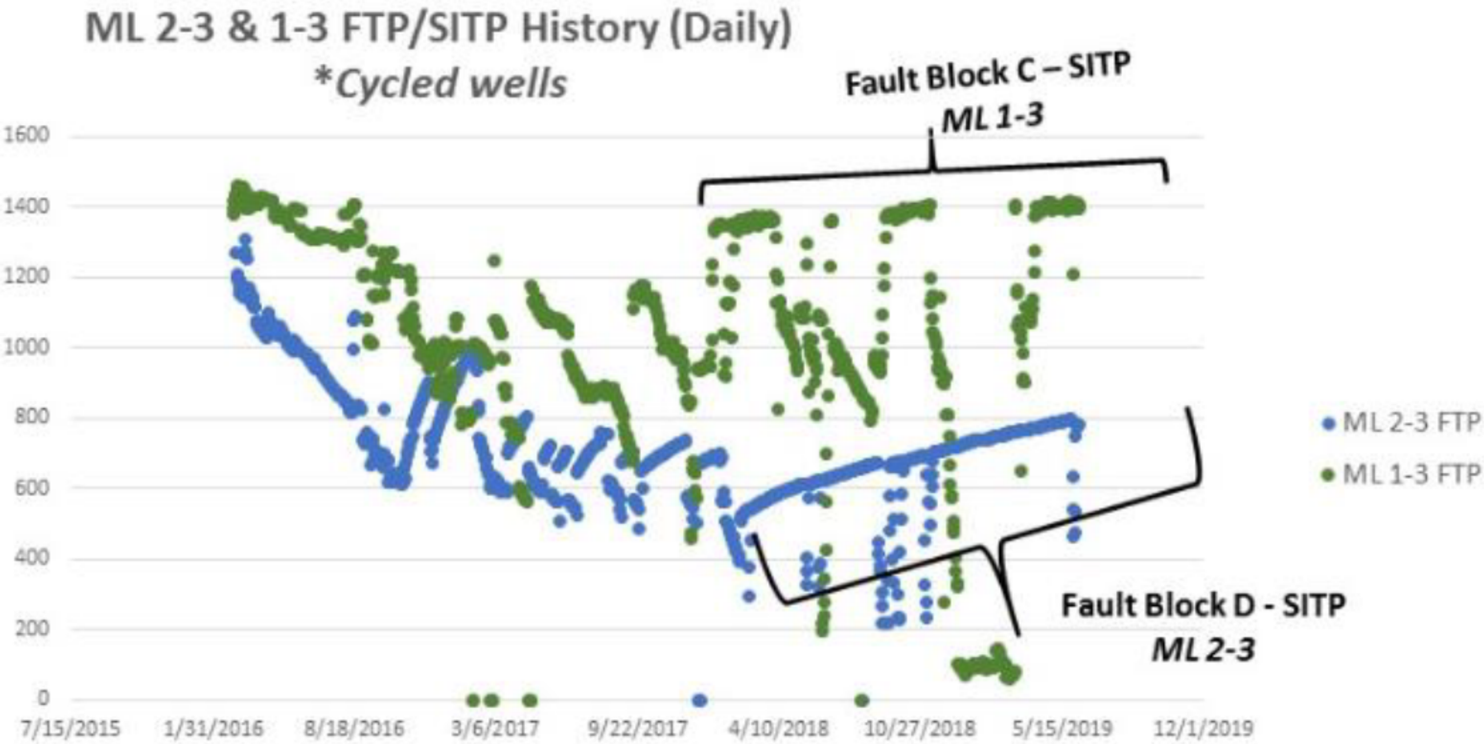


Exhibit VIII-F

<u>**Comparing Fault block D to Fault block C (ML 1-3 to ML 2-3)**</u>

See: Structure Map Exhibit VIII-D; Cross Section Exhibit VIII-E; and Pressure vs. time plot Exhibit VIII-F

- The ML 2-3 (fault block D) and ML 1-3 (fault block C) are in adjacent fault blocks that are isolated from each other.
- These two wells came on line at approx. the same time in Mar 2016.
- They both exhibited similar SITP and FTP early on in their life, however it is clear that the fault blocks are separated due to the well performance/recoveries and pressure loss within their respective reservoirs.
- Due to both wells being cycled wells (shut in and turned on after certain periods of time), you can see the buildup pressures (SITP) are significantly different between each cycle - ML 1-3 tends to build up to 1300 psi +/- vs 700 psi +/- in the ML 2-3.
- Additional justification to prove these wells / fault blocks are not in communication is while one well is on line producing, the other wells SITP is either static or building slightly. If in communication, you would see a decrease in SITP from the shut in well while producing the neighboring well.
- See pressure vs time plot on **Exhibit VIII-F**, as well as structure map **Exhibit VIII-D** & X-section **Exhibit VIII-E**

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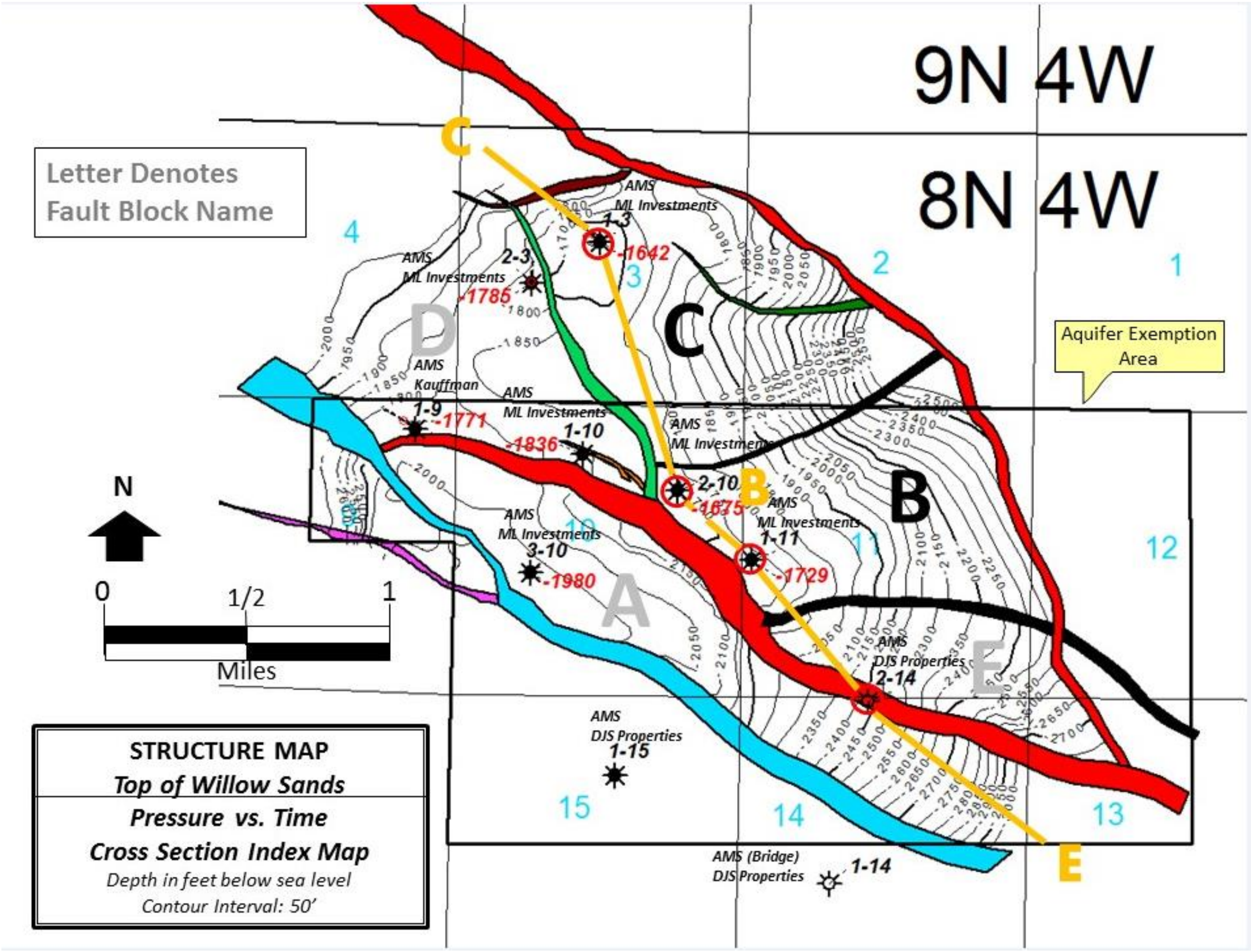


Exhibit VIII-G

Lateral Seal Fault Seal Competency: Fault Blocks C and B Comparison

The datum for the structure map above is top of the Willow Sands depth below sea level. The cross-section C-B-E shown to the right has a northwest to southeast line of section and is indicated on the map above. It traverses 3 fault blocks and runs along the axis of the Willow Field. The structurally highest well at top Willow Sands is the ML #1-3 (-1642' subsea). It has produced most of its ultimate reserves (2.76 Bcfg) from this water drive reservoir and is cycled (produced periodically) as gas builds up. It has lowest known hydrocarbons at -1809' subsea.

The intermediate fault block B lies downdip and upthrown across a small 40' fault, it has 2 wells that are structurally low to the ML #1-3 that are still producing daily. These are the ML #2-10 (-1675', 33' low) and the ML #1-11 (-1729, 87' low). These 2 wells have a common original GWC @ -1888'. As these wells still produce economically long after the ML #1-3 has essentially "watered out", this is strong evidence that the 40' fault seals and separates the 2 reservoirs C & B.

Fault block B is a depletion drive reservoir, with declining pressure as the hydrocarbons are produced, while fault block C is strong water drive. This strongly supports the sealing competency of the small fault. These conclusions are supported on the following pages.

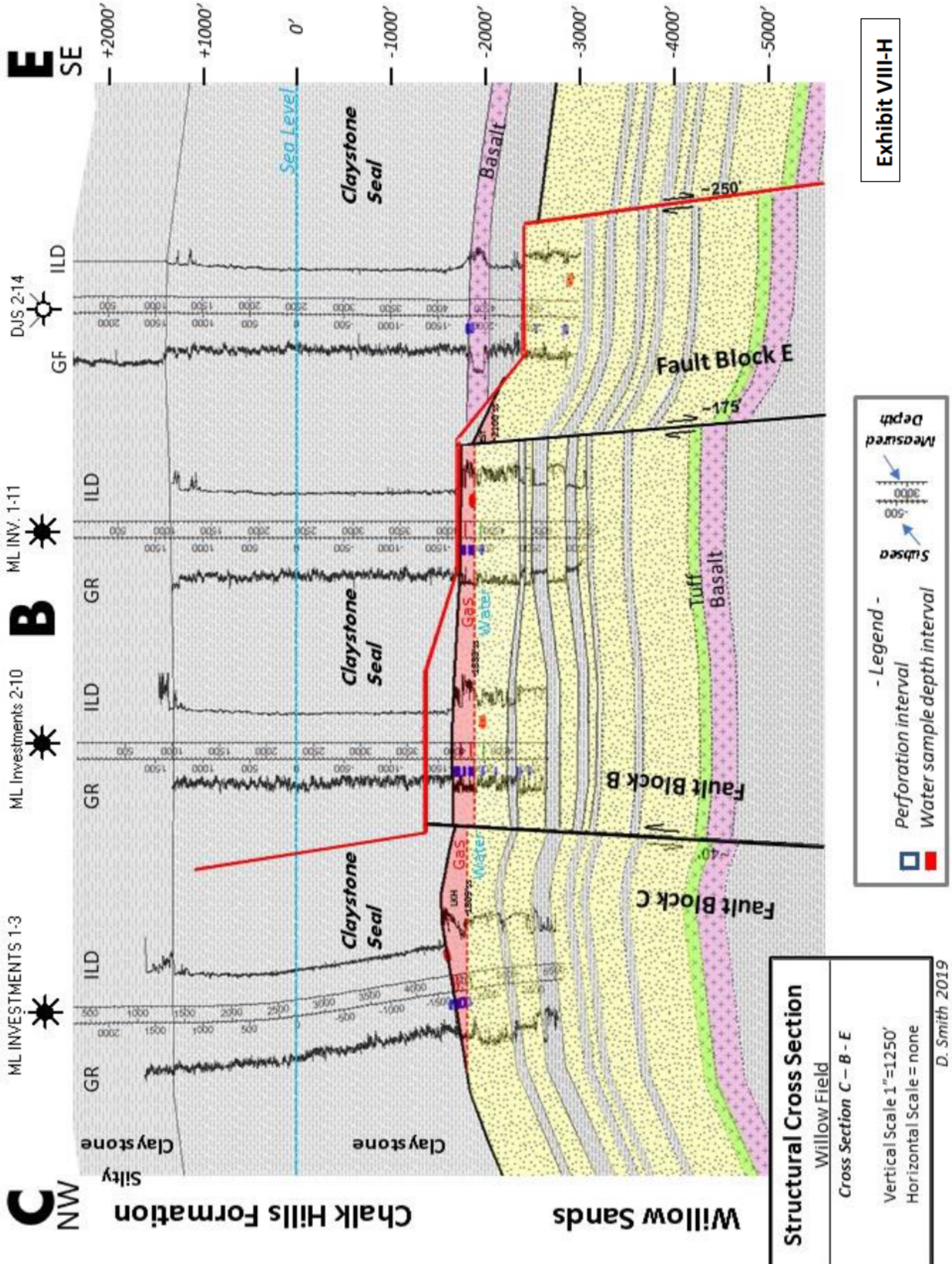
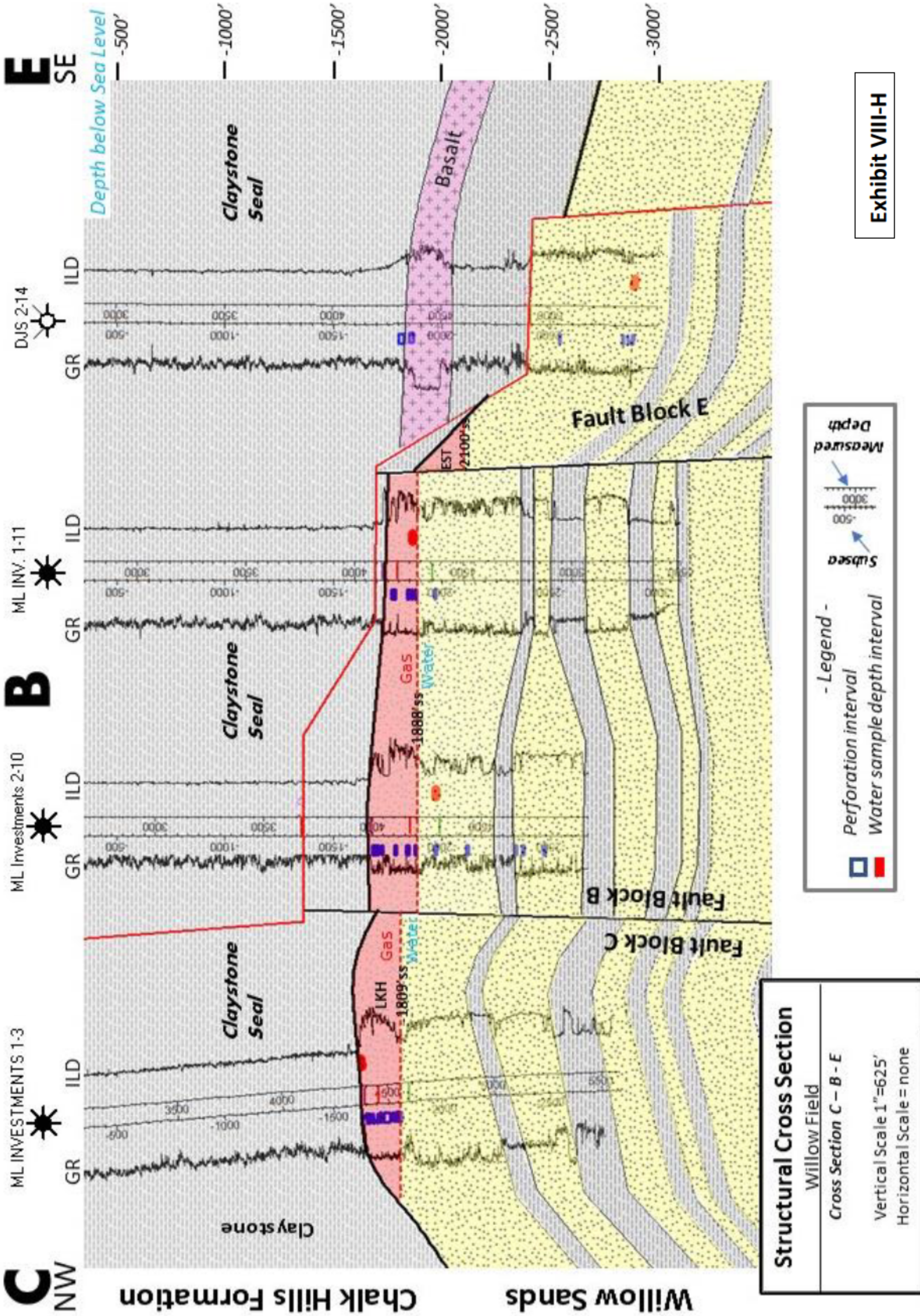


Exhibit VIII-H
C NW
E SE
B
ML INVESTMENTS 1-3
ML Investments 2-10
ML INV. 1-11
DJS 2-14
GR
ILD
GF
+2000'
+1000'
0'
-1000'
-2000'
-3000'
-4000'
-5000'
Sea Level
Claystone Seal
Basalt
Tuff
Gas
Water
Fault Block E
Fault Block B
Fault Block C
-250'
-175'
-40'
Silty Claystone
Claystone
Chalk Hills Formation
Willow Sands
- Legend -
Perforation interval
Water sample depth interval
Subsea
Measured Depth
Structural Cross Section
Willow Field
Cross Section C – B – E
Vertical Scale 1"=1250'
Horizontal Scale = none
D. Smith 2019

Exhibit VIII-H



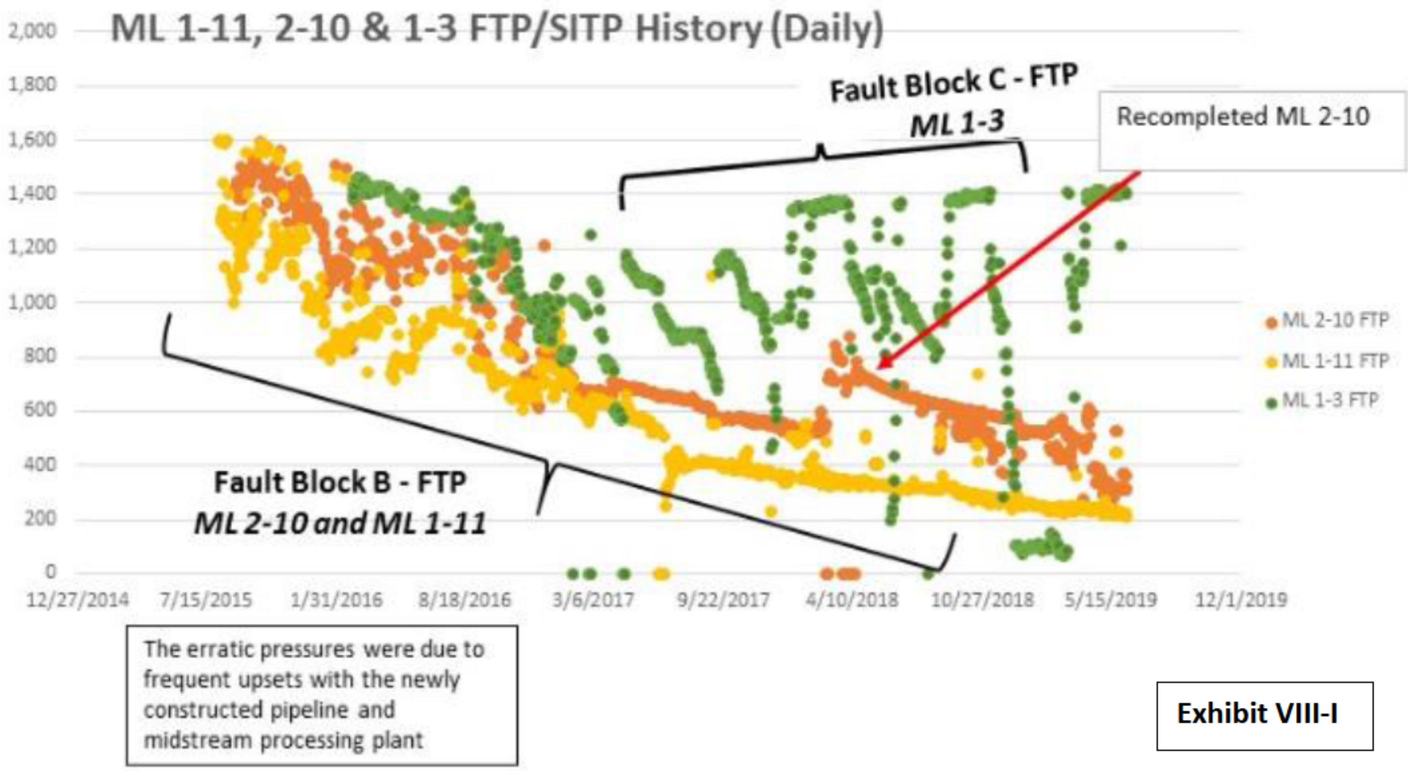


Exhibit VIII-I

Comparing Fault block B vs Fault block C (Comparing ML 1-3 to ML 2-10 & ML 1-11)

See: Structure Map Exhibit VIII-G; Cross Section Exhibit VIII-H; and Pressure vs. time plot Exhibit VIII-I

The ML 1-11 and ML 2-10 both are producing in a volumetric reservoir and are partially pressure depleted (depletion drive). The ML 1-3 is in the adjacent fault block to the north (fault block C), and completed in the same reservoir section as the ML 1-11 and ML 2-10. The ML 1-3, however, exhibits classic water drive behavior. Based on the characteristics of the Pressure versus Time (P vs T) plot, it is evident that the Shut in tubing pressure (SITP) builds up to virgin SITP each time the well is cycled on/off. This is strong evidence that the reservoirs of these two fault blocks are not in communication and have lateral seal competency between them.

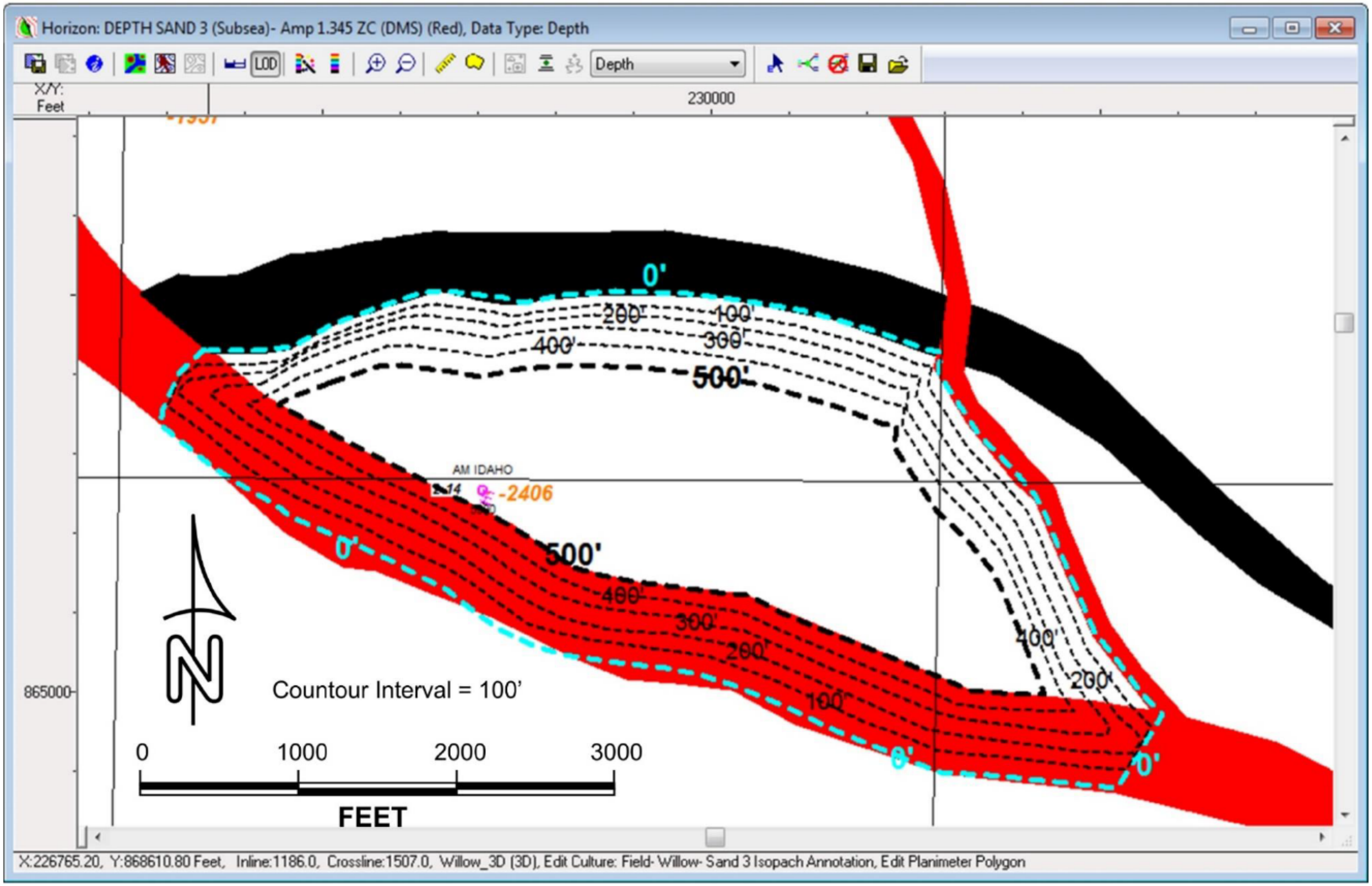
IX. Discussion of Boundaries of Proposed Aquifer Exemption Area

This aquifer exemption request is submitted along with an injection permit application for the DJS #2-14 well (currently shut-in). If approved, our plan would be to inject the water (which is produced along with the gas and condensate from the Willow Sands) back into the Willow Sands aquifer using the existing DJS #2-14 wellbore. The DJS #2-14 wellbore is in fault block E in the Willow Sand section, bounded on either side by fault blocks A and B **(Refer to Exhibits VIII-G & H on pages 72-74).**

Exhibit IX-A is an isopach map of the partial Willow Sand section which is penetrated by the DJS #2-14 wellbore. This wellbore encountered over 500’ of the Willow Sand interval from around 4900’ to total depth of 5500’. The gross isopach was made using the 3-D seismic volume and the subsurface control from the area wells drilled.

A calculation of the expected injection reservoir capacity was performed. This calculation assumes a confined reservoir pore space as defined by the isopach of the injection zone in a fault block bounded on 3 sides by faults. The bulk volume is calculated by determining the area of each isopach interval and using the average of the areas to calculate the total bulk injection reservoir volume. A porosity of 23% is estimated from open hole wireline logs for the injection interval. Water saturation is estimated at 80%, with a complementary 20% gas saturation. This is based on the swab test of the 5380’- 5390’ perforations, where gas blows were experienced and a water sample showed the presence of Benzene and other VOC’s naturally associated with water associated with hydrocarbon reservoirs. The average net reservoir to bulk thickness ratio is estimated at 90% from a review of the mud log for this interval. The pore space is estimated to contain 152 million reservoir barrels. Under confined injection, the water, gas, and pore space will compress and expand respectively to allow for water influx as pore pressure increases. The maximum allowable pressure is defined by staying 10% below fracture pressure. Fracture pressure is estimated to be equivalent to a 12 lb/gallon gradient (3214 psi at 5150’). Note that the actual parting pressure will be well defined upon completion of the well by the execution of a step rate test. The original pressure is estimated at a pressure equal to an 8.6 lb/gallon equivalent pressure gradient (2276 psi at 5150’). The maximum allowable pressure used in the calculation of Injection Zone Capacity is 90% of the fracture pressure (90% of 3214 = 2892 psi). This provides for an allowable increase in the reservoir pressure of 616 psi (2892-2276). Water, gas, and pore space compressibility’s are estimated using standard oil and gas industry correlations. Based on the original reservoir volume, along with the allowable pressure increase and the sum of the compressibilities, it is estimated that a total of 7,773 thousand reservoir barrels can be injected into this space before the pressure limit is reached. This equates to 7,368 thousand stock tank barrels based on a water reservoir volume factor of 1.055 RB/STB. Stock tank barrels are measured at atmospheric pressure and 60 degrees F. See **Exhibit IX-B** for volumetric calculations in fault block E.

[redacted]



DMS 9/2017

Calculation of Confined Injection Zone Capacity

DJS Properties #2-14 Injection Zone

Calculation of Reservoir Volumes:

Porosity	0.23	fraction	from well log
Sw	0.80	fraction	water saturation - evidence of gas in swab testing and water analysis
Sg	0.20	fraction	gas saturation - evidence of gas in zone from swab testing - residual gas
Gross Volume	94,700	acre-ft	from planimetry calculations below
Net/Gross Ratio	0.90	fraction	from well logs
Pore Volume	19,603	acre-ft	

Reservoir Isopach Area Planimeter Readings:

CONTOUR LINE VALUE	AREA > (acres)	RATIO OF AREAS	DELTA CONTOUR (ft)	DELTA VOLUME (acre-ft)	
0	269.00				
100	234.00	0.8699	100	25,150.0	
200	205.00	0.8761	100	21,950.0	
300	173.00	0.8439	100	18,900.0	
400	144.00	0.8324	100	15,850.0	
500	113.00	0.7847	100	12,850.0	
		TOTAL ==>		94,700.0	acre-ft - gross bulk reservoir volume

Injection Zone Capacity

Item	Value	Units	Comments - notes
Datum Depth:	5150	ft, BGL	average depth of injection zone
Average Temperature	251	deg F	ML Investments 1-3 production log
Initial Pressure:	2276	psi	8.6 ppg equivalent pore pressure at datum depth
Fracture Pressure:	3214	psi	12 ppg equivalent pore pressure at datum depth
Maximum Allowable Pressure	2892	psi	90% of fracture pressure
Maximum Pressure Increase (dP)	616	psi	maximum allowable pressure less initial pressure
Average Pressure	2584	psi	average of initial pressure and maximum allowable pressure
Water Salinity	750	ppm Cl	estimated average
Water Compressibility	3.48E-06	1/psi	Osif's Correlation
Gas Compressibility	3.87E-04	1/psi	Meehan et al, Gas gravity = 0.65 from ML Investments 1-10 Well
Rock pore volume compressibility	3.50E-06	1/PSI	Hall's Correlation
Reservoir Water Volume Initial	15,682	acre-ft	Pore Volume * Sw
Reservoir Water Volume Initial	121,663,439	RBbls	Pore Volume * Sw
Reservoir Water Volume Compression	261,022	RBbls	dP * water compressibility* initial water volume
Reservoir Gas Space Volume Initial	3,921	acre-ft	Pore Volume * Sg
Reservoir Gas Space Volume Initial	30,415,860	RBbls	Pore Volume * Sg
Gas Pore Space Compression	7,250,191	RBbls	dP * gas compressibility * initial gas volume
Pore Space Volume Increase	262,281	Rbbls	dP * pore space compressibility
Total Pore Space volume increase	7,773,494	RBbls	sum of water, gas, and pore space compression
Bw (water formation volume factor):	1.055	RBbl/STBbl	McCain's Correlation
Total Stock Tank Barrels Capacity	**7,368,241**	**STBbls**	adjust to surface conditions by dividing by water formation volume factor (Bw)

The facts presented in a series of case studies in **Section VIII** strongly suggests that water injected into the Willow Sands aquifer in fault block E should stay in fault block E. This statement is based on the documented examples of competent top, lateral and bottom seals in the neighboring fault blocks A and B. **Exhibit IX-C** shows the movement of hydrocarbons and water in the neighboring fault blocks A and B. If injected fluids did leave fault block E they would go into fault block A or B, which are both lower pressure than fault block E due to them having produced volumes of gas, condensate and water. In this scenario, the injected water would return to the same fault blocks from which it came. The requested Aquifer Exemption area is designed to include the neighboring fault blocks A and B to account for this possibility. Injectate possibly travelling into the neighboring fault blocks in the Willow Sands would have no effect on any underground sources of drinking water in the area. As previously discussed in section IV, there are no water wells which use this reservoir within a 24 square mile search area. The small number of water wells in the aquifer exemption area are no deeper than 215' and separated from the Willow Sands by thousands of feet of claystone.

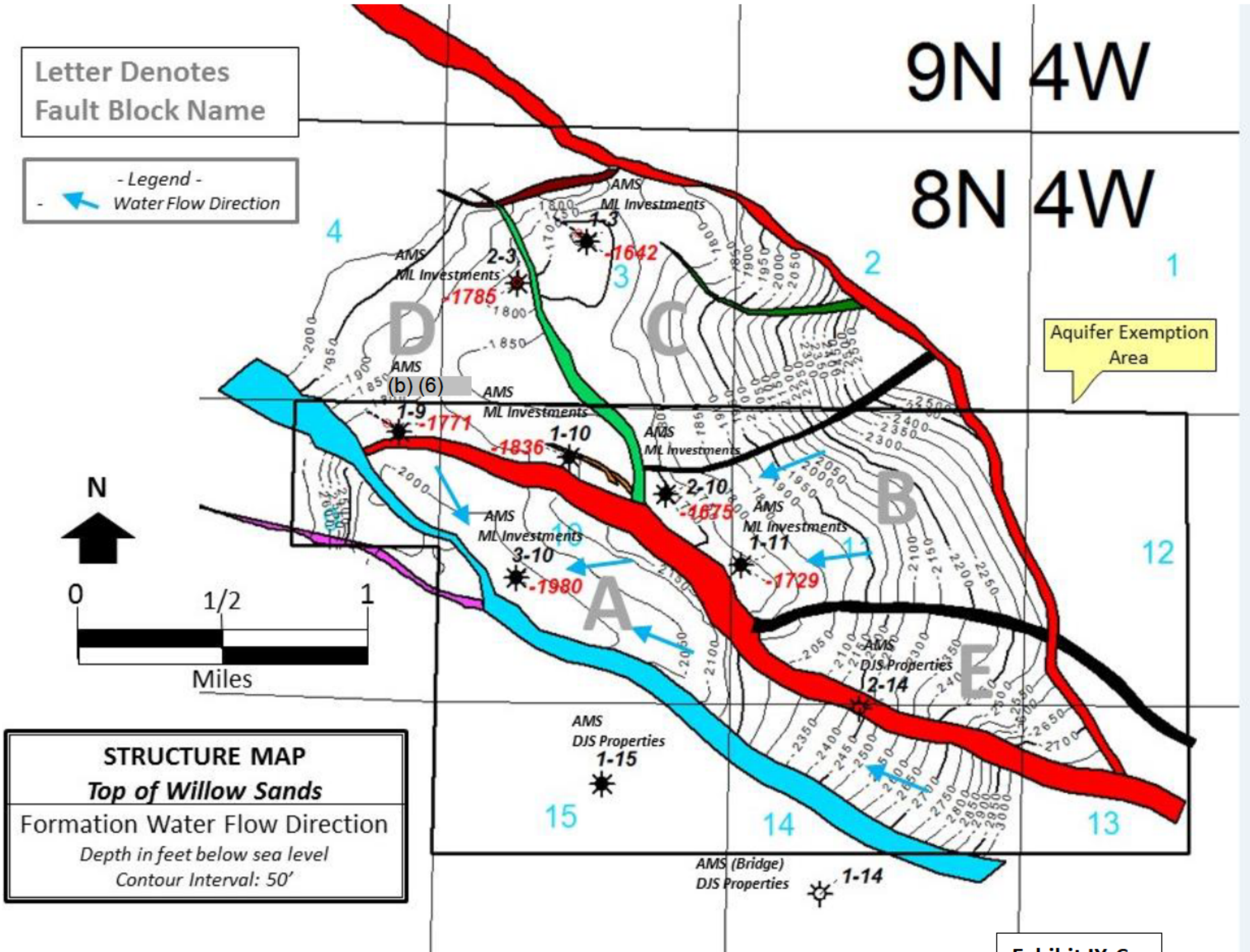

Letter Denotes
Fault Block Name
- Legend -
Water Flow Direction
9N 4W
8N 4W
Aquifer Exemption
Area
N
0
1/2
1
Miles
STRUCTURE MAP
Top of Willow Sands
Formation Water Flow Direction
Depth in feet below sea level
Contour Interval: 50'
A
B
C
D
E
AMS
ML Investments
1-3
-1642
2-3
-1785
AMS
(b) (6)
1-9
-1771
1-10
-1836
2-10
-1675
3-10
-1980
1-11
-1729
AMS
DJS Properties
2-14
1-15
AMS (Bridge)
DJS Properties
1-14
1
2
3
4
12
13
14
15

Exhibit IX-C

X. Evidence Supporting <u>40 CFR 146.4 (b)(2)</u>

"It is situated at a depth or location which makes recovery of water for drinking water purposes economically or technologically impractical"

The Willow sands in this area should not be considered as a viable source for drinking water due to their overall cost burden to drill and complete a water well at the depth of the proposed Aquifer Exemption area (5000'- 6000'). The depth disparity between the current water wells in the area and oil and gas wells is monumental and it would be grossly uneconomic and inefficient to consider drilling a water well which penetrates, and is completed within the Willow sands in the outlined Aquifer Exemption area.

The typical depth of all water wells within the proposed aquifer exemption area is 127' With the maximum water well depth being 215'.
The average depth for all oil and gas wells drilled and completed (producing and shut in) within the Willow Field area is 5000' to 6000'.

<u>Average Cost to Drill and Complete</u>

- The most recent well drilled is the Fallon 1-10 in the Harmon field. To drill and complete this well to the depth of 5,434' cost approximately $2,950,000 as of 2/22/18 .
- To drill to the depth of 300' the cost would be approximately $25,000 (quote from Hydro Logic, Inc 8/21/19) See quote from Hydro Logic, Inc in **Appendix X**.

XI. Evidence Supporting 40 CFR 146.4 (b)(3)

"It is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption."

The proposed exempted aquifer would not serve as a viable source of drinking water in the future as the water within this hydrocarbon producing sand is contaminated with various VOC's (Volatile Organic Compounds) including Benzene, Toluene, Ethylbenzene, and Xylene (BTEX).

There are multiple produced water samples that have been taken from these very sands and all have shown some level of BTEX. **Exhibit XI-A**. BTEX exposure at certain concentrations can be toxic to humans, effecting kidneys, liver, eyes and respiratory issues as well.

All water samples in **Exhibit XI-A** were pulled from a separator, a vessel that collects the full well stream from each well when it is on production. This vessel is the first line of separation from the producing well bore. Additionally, there are no injection wells within the hydrocarbon producing area/formations, proving that the produced water is native to the formation. Furthermore, the water samples taken from the 8 wells referenced in the table all share similar characteristics across the hydrocarbon producing field. See **Appendix VII** for the full water sample analyses.

Water Analyses from Willow Sand Aquifer

	Date	Formation	Depth	Total Dissolved Solids (TDS)	Benzene	Toluene	Ethylbenzene	Xylene	Appendix
Well Name	Sampled	Sampled	(MD ft)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	
AMS DJS 2-14	10/22/2014	Willow Sand	5380	3150	1510	830	55	390	App. VII
AMS DJS 1-15	5/28/2019	U. Willow Sandy Silts	3756	1540	3030	1930	178	89	App. VII
AMS(b) (6) 1-9	3/19/2015	Willow Sand	4560	2600	2142	2335	548	661	App. VII
AMS ML Investments 1-3	5/30/2019	Willow Sand	4379	1300	775	1690	349	1800	App. VII
AMS ML Investments 1-11	10/9/2014	Willow Sand	4262	5950	8900	7800	600	3490	App. VII
AMS ML Investments 2-3	5/30/2019	Willow Sand	4462	1010	1650	2710	772	4290	App. VII
AMS ML Investments 2-10	3/20/2014	Willow Sand	4288	1650	4280	4150	425	2480	App. VII
AMS ML Investments 3-10	5/26/2019	Willow Sand	4246	510	2210	3730	1010	4460	App. VII
AMS ML Investments 1-10*	4/26/2010	Willow Sand	4225	1210	*See note below				App. VII
Sample #1	1/5/2013	Willow Sand	4096	2034	*See note below				App. VII
Sample #2	1/5/2013	Willow Sand	4096	2137	*See note below				App. VII
Sample #3	1/5/2013	Willow Sand	4096	15982	*See note below				App. VII
	2/16/2016	Willow Sand	4096	1349	*See note below				App. VII

*NOTE: ML 1-10 - A water analysis was performed for this well, but the sample was not run for BTEX. However, gas and condensate samples were pulled in which both samples showed to have concentrations of BTEX as well as other hydrocarbon components.
See ML 1-10 Gas and Condensate analysis in Appendix App. S-10 and S-11

Exhibit IX-A

XII. Summary

Applicant concludes that the Willow Sands aquifer is eligible for an exemption determination under 40 CFR 146.4. A rigorous review of the Idaho Department of Water database of water wells over a 24 square mile search area surrounding the requested 4 square mile exemption area shows that the deepest water well is 415'. The Willow Sands aquifer is at a depth below 4000', therefore it is not currently being used as a source of drinking water. This meets the 146.4 (a) condition ***"it does not currently serve as a source of drinking water; and "***. **Section IV** addresses this search.

The Willow Sands aquifer is a commercially producing gas condensate field (Willow Field) in the requested aquifer exemption area. Therefore this application request meets the standard under 40 CFR 146.4 (b)(1) ***"It cannot now and will not in the future serve as a source of drinking water because: (1) It is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible."*** **Sections V through VIII** provide evidence that the Willow Sands aquifer is a commercially producing hydrocarbon reservoir.

40 CFR 146.4 (b)(2***)*** states that an aquifer may be determined to be exempt if: ***"it cannot now and will not in the future serve as a source of drinking water because… (2.) it is situated at such a depth or location which makes recovery of water for drinking water purposes economically or technologically impractical; or"..***

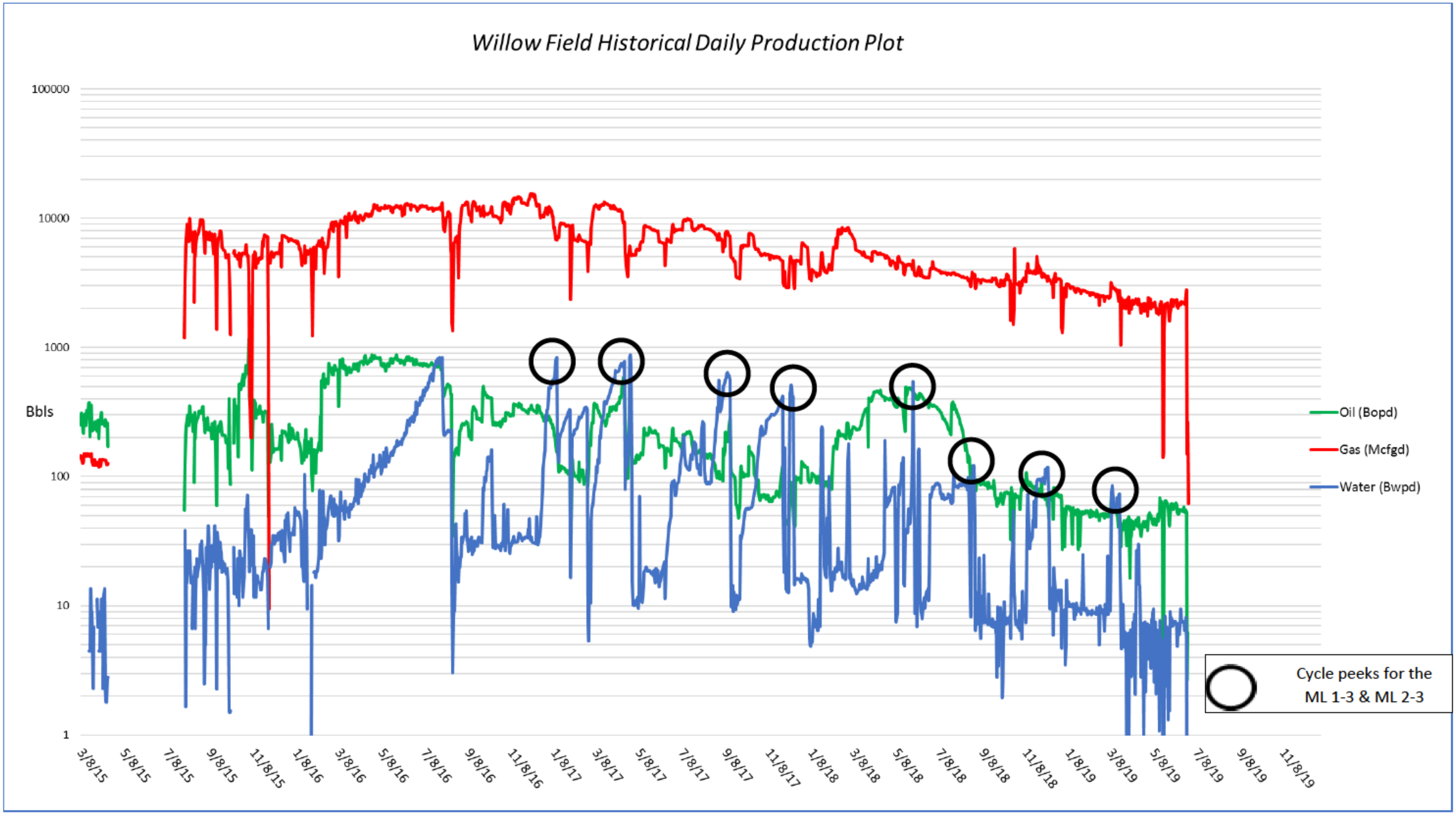
The cost to drill and complete a 5000' to 6000' well to the Willow Sands to produce water is estimated to be $2.9 to $3.0 Million, based on the 11 similar depth wells that we have drilled in the area. There are other much shallower zones locally that are currently being used (60' to 300') for drinking water where wells can be drilled for $25,000. It does not make economic sense to spend over 100 times the amount needed to drill a shallow well to drill a water well to the Willow Sands aquifer. As this area is rural and very lightly populated, and the current water needs are being met by shallower aquifers, it simply does not make economic sense to drill deep, 5000' to 6000' wells to access water in the Willow Sands aquifer. This point is discussed in more detail in **<u>Section X</u>** of this application.

40 CFR 146.4 (b)(3) states that an aquifer may be determined to be exempt if: ***"it cannot now and will not in the future serve as a source of drinking water because… (3.) it is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption, or…"***

We have done extensive sampling and analyses of the water contained in the Willow Sands aquifer. The water samples analyzed from the aquifer show the presence of benzene, toluene, ethylbenzene and xylene in levels unacceptable for drinking water. The levels measured are consistent with the fact that commercial hydrocarbons are present in the reservoir, these species of hydrocarbons are very commonly found in oil and gas fields. We have had third party analyses done of the cost to treat the water to render it useable for drinking and the costs are economically prohibitive.

The Willow Field wells produce fresh water along with the oil, gas and condensate. This produced water is separated onsite and trucked 70 miles (140 miles round trip) to an evaporative disposal site near Kuna, Idaho. Applicants intention is obtain approval to reinject the associated fresh water produced from the wells back into the same Willow Sand reservoir from which it came. This local reinjection of the produced water would have multiple benefits to the local landowners, the community, the environment and the applicant.

1. Reinjecting the associated produced fresh water in the field versus trucking it to disposal, would eliminate an estimated 250,000 to 300,000 miles of truck traffic every year, for multiple years. This potential injection scenario therefore would significantly reduce emissions into the airshed for multiple years. It also would improve community safety by reducing heavy vehicle traffic and the possibility of accidents involving trucks hauling water. These factors benefit the environment in the region and lessen the potential impact of our operations within the community.
2. Reinjection of produced water back into the Willow Sands could be done at a fraction of the cost of the current method of hauling water to evaporative disposal. This scenario extends the economic life of existing wells and adds to the ultimate amount of oil and gas that can be produced economically. These extra volumes of hydrocarbons mean increased revenue to the local landowners and to the state of Idaho in extra tax revenue.
3. Reinjecting produced water complies with the stated purpose of the Idaho Oil and Gas Conservation Act (the “Act”), which is to encourage and promote development, prevent waste, and protect correlative rights. Maximizing efficient recovery of minerals is a part of preventing waste of the resource. Extending the productive life of the Willow Field and therefore increasing the ultimate hydrocarbon production through implementing an economically advantaged injection well is highly conformable to stated goals of the established Idaho mineral law.



Note: See production cycles starting in late 2016. ML 1-3 and 2-3 have both been on a cycling program due to their water production nature. These wells are uneconomic once they begin to produce certain amounts of water and therefore require a shut-in period. With an injection well for disposal this would not only allow for these two wells to become economically viable, but the entire field production would experience the same benefit.